Final Report

Demonstration of the Marine Towed Array on Bahia Salinas del Sur Vieques, Puerto Rico

ESTCP Project MM-0324

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SAIC

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14. ABSTRACT: From 1-30 June 2007 SAIC, using the Marine Towed Array conducted a MEC sur ey of the Bahia Salinas del Sur and adjacent areas. The Bahia encompasses an area of 0.5X0.75 nautical miles. Water depths vary from breaking surf to slightly over 30 ft. The bay bottom consists of areas of open sand, areas covered bymarine sea grasses, and coral reefs in about equivalent extents. The center of the Bahia is dominated by the wreckage of the Killen, a former target ship, which was sunk by Naval gunfire. The entire Bahia lies within the Live Impact Area of a former Naval training range, which was used for over 50 years by ships and aircraft. Magnetic anomalies discovered in the impact area were analyzed to determine their positions, sizes, possible identities. Anomalies judged to potentially be ordnance were organized into target tables to support possible future intrusive investigations and/or recoveries. The target tables identified more than 600 anomalies that are recommended for investigation.

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LIST OF ACRONYMS

Acronym	Explaination		Acronym	Explaination
ASR	Archives Search Report		MM	Military Munitions
AFTWA	Atlantic Fleet Weapons Training Facility		MTA	Marine Towed Array
BRAC	Base Realignment and Closure		MTADS	Multi-sensor Towed Array Detection System
BSDS	Bahia Salinas del Sur		NASD	Naval Ammunition Support Detachment
CAD	Computer Assisted Design		NOAA NMSP	National Oceanographic and Atmospheric Agency, National Marine Sanctuaries Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act		nT	nanotesla
COG	Course-Over-Ground		montaj	Trademark copyrighted by Geosoft
COR	Contracting Officer's Representative		NAD	North American Datum
COTS	Commercial, Off the Shelf		NATO	North Atlantic Treaty Organization
CTT	Closed, Transferred, and Transferring		Navfac	Naval Facilities Command
DAQ	Data Acquisition System		NEODTD	Naval Explosives Ordnance Detection Technology Division
DAS	Data Analysis System		NOSSA	Naval Ordnance Safety and Security Activity
DIDSON	Dual-Frequency Identification Sonar		NPL	National Priorities List
DGPS	Digital Global Positioning System		OIC	Officer in Charge
DNER	Department of Natural and Environmental Resources		OSHA	Occupational Safety & Health Administration
DoD	Department of Defense		POS	Prove-Out-Site
DOI	Department of Interior		QA	Quality Assurance
DVD	Digital Video Disk		QC	Quality Control
EE/CA	Engineering Evaluation/Cost Analysis		R&D	Research and Development
EMI	Electromagnetic Induction		RAB	Research Advisory Board
EOD	Explosive Ordnance Disposal		RI/FS	Remedial Investigation/Feasibility Study
EOTI	Explosive Ordnance Technology Inc.		RCRA	Resource Conservation and Recovery Act
EMA	Eastern Maneuver Area		RDU	Raleigh-Durham International Airport
EPA	Environmental Protection Agency		RFQ	Request for Quotation
ESTCP	Environmental Security Technology Certification Program		RTK	Real-time Kinetic
FUDS	Formerly Used Defense Site		SAIC	Science Applications International Corp.
GP	General Purpose		SCI	Structural Composites Inc.
GPS	Global Positioning System		SERDP	Strategic Environmental Research and Development Program
GUI	Graphical User Interface		SJU	San Juan International Airport
HAE	Height Above Ellipsoid		SIA	Surface Impact Area
Hz	Hertz		SOW	Statement of Work
Knot	Nautical Mile per Hour = kt		TCRA	Time-Critical Removal Action
km	Kilometer		USACE	US Army Corps of Engineers
lb	pound		UTM	Universal Transverse Mecator
LCM	Landing Craft Marine		UXO	Unexploded Ordnance
LIA	Live Impact Area		UK	United Kingdom
Mb	megabyte		USS	United States Ship
MEC	Munitions and Explosives of Concern		VCT	Vehicle Control Technologies, Inc.
MHz	megahertz		VNTR	Vieques Naval Training Range

Acknowledgments

The MTA demonstration in the Bahia Salinas del Sur (Vieques) was sponsored by ESTCP. We would like to acknowledge the continual leadership and support over many years by Dr. Jeff Marqusee and the technical advice, direction, and support of the Munitions Management project area managers, Dr. Anne Andrews and more recently Dr. Herb Nelson.

Additionally, we would like to thank Mr. John Dow (NOSSA) for his guidance, and support from the Proposal and IPR Tables at ESTCP and his encouragement and DoD support contacts behind the scenes.

Our demonstration in the Bahia was conducted in coordination with NAVFAC Atlantic Division, the Vieques Cleanup Operations Site Managers. We wish to acknowledge the support of Mr. Johnny Noles and Mr. Chris Penny both before and during the demonstration. They coordinated our operations with the Naval Personnel (at Camp Garcia), with their various UXO cleanup operations contractor groups on the LIA, and they assisted with stakeholder acceptance on Vieques. Additionally, they supported the installation of the targets in the Calibration Line and the installation of the mooring sites within the Bahia.

We would like to express our appreciation to our supporter and partner in Vieques, Mr. Pete Seufert of Sea Ventures who (with a smile) allowed us to bore many holes in and screw many odd looking attachments onto his dive vessel. We would also like to thank Mr. Pedro Rodriguez, first mate on the Coral Queen, who lived 24/7 on the vessel for a month and always had a smile and a joke, no matter how weird our requests may have sounded.

Our operations on Vieques were carried out by our SAIC support crew of four; myself, Chet Bassani, Chris Gibson, and Nagi Khadr. Except for the 12 mile high seas commute twice a day, the whole operation took place efficiently and with good cheer, even with rain in our faces, the cabin full of diesel exhaust, and the boat rolling $\pm 15^{o}$ all day long.

EXECUTIVE SUMMARY

SAIC, using the Marine Towed Array and a newly-outfitted very shallow water survey skiff, conducted a demonstration survey of the Bahia Salinas del Sur off the south shore of Vieques Island. From the early 1950's until 2003 the eastern half of Vieques Island served as the Vieques Naval Training Range (VNTR). It was used for ground warfare, amphibious training for Marine and naval gunfire support training, and air to ground training. Joint exercises with other NATO countries were also conducted. The eastern tip of the island was constituted as the Live Impact Area (LIA); the Bahia Salinas del Sur lies almost entirely within the LIA.

Environmental cleanup in the VNTR began in 2000 under a RCRA consent order. In 2003, ~14,600 acres of the VNTR was transferred to the DOI as a wildlife refuge. In 2005 the VNTR was placed on the National Priorities List (Superfund) and cleanup on land began, taking place under CERCLA guidelines. The Navy began a PA/SI in 2005, followed by TCRA cleanup activities in the most contaminated areas of the LIA. In 2006 NAVFAC Atlantic Division began preliminary activities to evaluate the types and extent of damage and contamination of the offshore areas in bays on both the north and south sides of the LIA. In late 2006 NOAA, working with NAVFAC, undertook new bathymetry mapping and environmental (coral) investigations of these areas. ESTCP, working in cooperation with NAVFAC Lant, sponsored a magnetometry geophysical demonstration survey of the Bahia Salinas del Sur and adjacent areas to map out the extent of the ferrous/MEC contamination. The geophysical survey employed the Marine Towed Array developed by SAIC specifically for these types of shallow water UXO investigations.

From 1-30 June 2007 SAIC conducted a MEC survey of the Bahia Salinas del Sur and adjacent areas. The Bahia encompasses an area of ~0.5 X 0.75 nautical miles. Water depths vary from breaking surf to slightly over 30 ft. The bay bottom consists of areas of open sand, areas covered by marine sea grasses, and coral reefs (in about equivalent extents). The coral in the main part of the bay is in fringing clusters, with some additional growths associated with solid bottom structures. The center of the Bahia is dominated by the wreckage of the Killen, a former target ship, which was sunk by Naval gunfire. The vessel broke up into several sections before sinking.

Areas of the Bahia less than ~6 ft deep were surveyed by the SAIC skiff array. The skiff could work in water as shallow as 1 ft, although it was not used in breaking surf. Approximately 80 acres were surveyed with the skiff. The main body of the bay (extending beyond two small islands guarding the entrance of the bay) was surveyed by the MTA. The MTA covered about 195 acres.

Anomalies judged to potentially be ordnance were analyzed to determine their locations, sizes, and burial depths. The results were organized into target tables to support possible future intrusive investigations or recoveries. The skiff survey target table contains 71 entries; the MTA table reports the results for 532 anomalies.

1.0 INTRODUCTION

1.1 Background

1.1.1 UXO in the Marine Environment: As a result of past military training and weapons-testing activities, UXO is known to be present at many sites designated for Base Realignment And Closure (BRAC) and at Formerly Used Defense Sites (FUDS). Many of these sites associated with military practice and test ranges contain significant land areas with a marine component. Although it is known that between 10 and 20 million acres of dry land UXO contamination are associated with Closed, Transferred, and Transferring (CTT) ranges, the fraction of this area that is underwater and inaccessible to standard UXO search technologies is poorly defined; however, it likely exceeds a million acres. The marine environment presents a complex challenge for UXO search technologies, because it includes wetlands, fresh water ponds and lakes, estuaries, rivers, coastal bays, tidal flats, and ocean shores, including shallow water coral reefs.

Although much of the marine UXO contamination has resulted from overshoots of land ranges, off-shore areas also have been used as ranges. The Live Impact Area (LIA) of the Former Vieques Navel Training Range associated with this project, primarily had target areas established on the Island. Much of the UXO contamination in the Bahia Salinas del Sur resulted from undershoots from Naval vessels and aircraft. However, sometime between the mid 1960s and the early 1970s the former Fletcher Class destroyer USS Killen (DD-593) was towed into the Bahia and sunk by Naval gunfire. The vessel broke up into three major pieces (and numerous smaller fragments). Over the subsequent 40 years this accidental reef has become populated with many coral species.[1-3]

There currently exist no commercial proven automated technologies for conducting UXO geophysical surveys that result in documented mapped data files showing the extent, densities, and types of ordnance contamination for the underwater environment. The application of automated survey technologies has become routine on land-based ranges using hand-held, man-portable, vehicular-towed, or airborne sensor arrays coupled to GPS (or other types of) navigation systems for precise location positioning. Currently, underwater UXO searches are typically conducted by divers using hand-held metal detectors. Discovered targets are either prosecuted as they are found or they are marked with weights and floats for later reacquisition.

SERDP in 2002 and ESTCP in 2003, issued calls for development and demonstration of Marine UXO survey systems for application in shallow water environments (up to 15 ft water depths) associated with current and former military ranges. In our 2002-2003 SERDP Project,[4] UX-1322, we carried out a marine engineering study of vessel parameters and sensor platform concepts and established designs for towed sensor platforms of 2 meters, 4 meters, and 10 m in width. We additionally carried out first-principles EMI modeling studies and parametric measurement studies with inert ordnance and established a working design for a time-domain EMI transmitter-receiver system that we predicted could be used to detect a 60 mm mortar from a stand-off distance of 1 m. Moreover, we concluded that both magnetometers and an EMI sensor array could be housed in the same sensor platform. Although they could not be operated

simultaneously, each could be independently used without interference from the other system. Results of these studies are documented in the Project Final Report.[5]

In our 2003 ESTCP Project MM2003-24, we designed and constructed a marine towed-array UXO sensor system.[6] This platform, with nominally 4-meter wide sensor arrays, is designed as an underwater flying wing. It is towed by a 20-meter cable attached to a 30-foot long triple pontoon boat. The maximum design operational speed is 5 kt. Assuming the system is used to survey 4 m wide lanes at 5 kt, the survey production rate is 3.7+ hectares/hour, or slightly less than 10 acres/hour. This does not count the time spent in turns or in raising or lowering the platform. The attitude and depth of the sensor platform is controlled by an autopilot operating from a computer on the tow vessel. The inputs to the autopilot include a tactical-grade IMU mounted on the sensor platform (determining pitch, roll, and yaw of the platform), depth sensors and digital magnetic compasses on both the platform and on the tow vessel, and a dual antenna GPS system on the tow vessel. The autopilot, which controls the sensor platform, can be programmed to either maintain a fixed standoff distance from the bottom interface or to maintain a fixed depth below the water surface. This system provides a truly unique capability for underwater UXO search systems. The survey products include digitally geo-referenced magnetic anomaly maps of metallic objects buried in the bottom sediments and Excel® tables reporting the results of analyses of individual anomalies. The full array of dipole-based target analysis capabilities developed for the MTADS ground and airborne survey systems has been adapted for this application. This system was first demonstrated in a large UXO survey in the Currituck Sound adjacent to the Former Duck Bombing Range near Duck, NC[7] in late 2005. The second demonstration of the MTA system under ESTCP Project MM2003-24 took place in Ostrich Bay (Puget Sound, WA) adjacent to the Former Naval Ammunition Depot Puget Sound.[8]

1.1.2 Vieques Island, Puerto Rico: Vieques is a small island located approximately 10 miles east of the main island of Puerto Rico. Vieques is 21 miles long east-to-west and is 3 miles wide with a total land area of 52 square miles. During the 1940's the U.S. Navy purchased 25,000 acres of land on Vieques on the eastern and western ends of the island. The acquired land was used for Naval gunfire support and air-to-ground training from the 1940's until May, 2003. The western sector of the island was used for the US Naval Ammunition Support Detachment (NASD), while the eastern sector of the island was used as the Vieques Naval Training Range (VNTR), Figure 1-1.[9]

The VNTR was divided into two areas: the Eastern Maneuver Area (EMA), which included Camp Garcia, was used for public works facilities to maintain vehicles, buildings, road and utilities used for military activities, and the Atlantic Fleet Weapons Training Facility (AFTWA) comprised of the Surface Impact Area (SIA), the Live Impact Area (LIA), and the Eastern Conservation Area. The VNTR was used from the early 1950's until 2003 for ground warfare and amphibious training for Marine naval gunfire support training and air to ground training. Additionally, joint exercises with other NATO countries were conducted. This is of importance because it implies that foreign-manufactured ordnance may also be encountered on the island and in the bay. Figure 1-2 shows an image of the Bahia Salinas del Sur and part of the LIA near the shoreline.

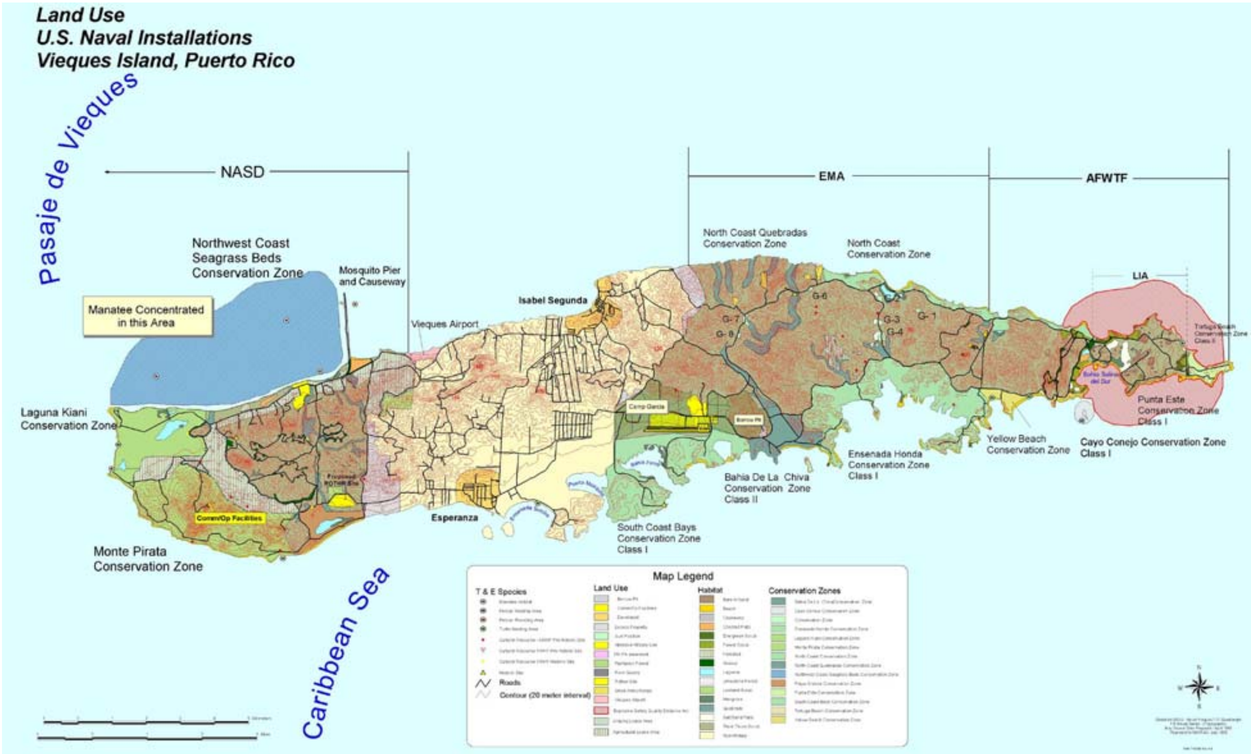

Figure 1-1: US Navy Installations Vieques, Puerto Rico (1999)

The light blue areas of sea bottom are sand. The darker areas on the sea bottom are primarily sea grasses. The fringing coral tends to appear as gray, although some areas are indistinguishable from the sea grasses. Military target areas on shore are noted as red dots (mostly within scarred land areas). Green dots in the bay mark known UXO identified by divers. The red bounded area was the intended survey area to be mapped in NOAA bathymetry studies.[10] All roads within the LIA are unimproved (sand, dirt, or gravel).

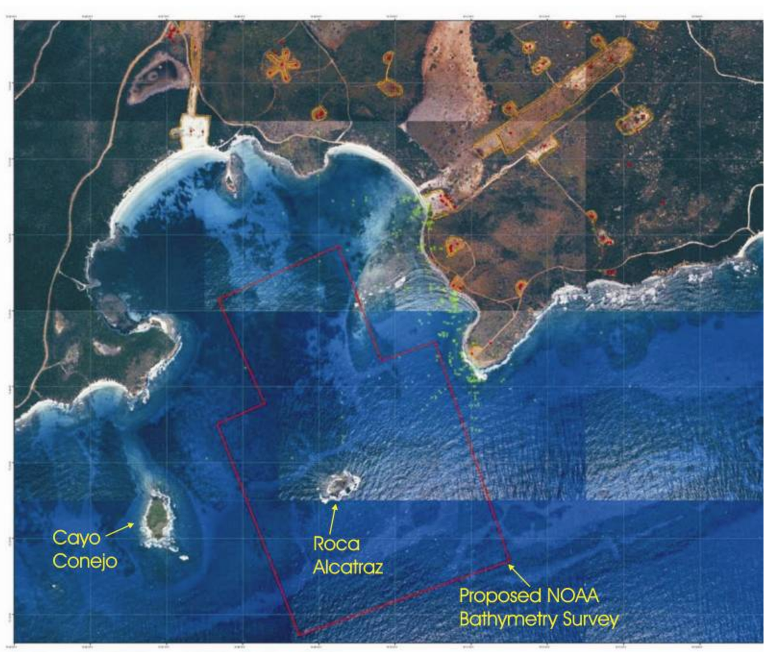

Figure 1-2. This 1999 mosaic of aerial photographs shows the Bahia Salinas del Sur with the two small islands identified that guard the mouth of the bay.

1.2 Objectives of the Demonstration

The demonstration on Vieques Island took place as part

of a site characterization and remediation project for the former VNTR site. Our activities are one of several marine survey and characterization studies that have taken place offshore of the VNTR.[10] Our site characterization study was not coupled with scheduled UXO investigation or recovery operation. Indeed, to date there have been no offshore UXO recovery efforts. Because this demonstration was intended to be completely nonintrusive, it was unnecessary to prepare an Explosives Safety Submission, or a Diver-based UXO Health and Safety Work Plan. Our project objectives, as described in our Demonstration Test Plan,[11] were focused on conducting an efficient and high-quality marine UXO Geophysical survey of areas of the Bahiá Salinas del Sur that were known to have UXO contamination. The results of this UXO survey can be used at some future date to support UXO investigation and removal actions in the surveyed areas.

The primary challenges of this site included:

- The variable bottom structure (coral deposits and sea grass) and the abruptly changing water depths;
- The presence of (The Killen) a Naval target vessel that was wrecked and sunk within the survey area;
- The availability of only primitive launch and recovery facilities near the survey area;
- The unavailability of overnight docking or mooring sites within several miles of the survey area;
- The presence of open sea conditions over much of the survey area requiring adapting our instrumentation to a charter vessel of opportunity;
- The long distances over which transportation and logistics issues had be worked; and
- International shipping and customs requirements.

The performance metrics that we established for measuring success of this demonstration included the following:

- System performance:
  - Establish on-site logistics to support efficient demonstration operations. (Efficiency was measured in lost time during the demonstration to establish or modify the required support).
  - Demonstrate efficient survey platform deployment and recovery operations. (Efficiency was measured in lost time at the beginning and ending of each day's operations to deploy and secure the system).
  - Evaluate component performance including actuators, navigation and location sensors, depth sounders, and the imaging sonar. (Efficiency was determined by the number and extent of breakdowns and work stoppages because of equipment failures, having necessary spares to quickly recover, and the inconvenience and expense of moving the platform for repair or for demobilization on seas that were too rough to tow the platform).

- Survey performance of the sensor arrays:

- Survey production rates are reported as hourly and daily survey rates (acres/hour or acres/day) for the periods of deployment of the array.
- Maximize coverage area and minimize missed survey areas. (Performance was determined from course-over-ground and missed area plots).
- Evaluate the ability of the survey guidance and sensor platform autopilot systems to accurately track a survey grid and maintain the intended platform altitude above the bottom.

• Data acquisition performance:

  - Efficient integrated performance of all systems supporting the autopilot, the pilot guidance display, the television cameras, and the magnetometer sensor data stream. (Performance is described in the Demonstration Report). The TV system was destroyed on the first survey day when we were ejected from the area by blasting operations on shore. The tow vessel anchor failed and the boat was continually pushed into the separately anchored sensor platform for over an hour.
  - It was intended to evaluate the performance of the EMI sensor array and the data acquisition system against the performance of the magnetometer array. The EMI sensor array had been once again rebuilt following the Lake Erie demonstration. The EMI system failed the first time it was turned on – the interface box flooded again.

• Creation of data products:

  - Mapped data files and images;
  - Target analyses; and
  - Target lists; and
  - Data products will be evaluated for suitability to support future target recovery operations.

1.3 Regulatory Drivers

The regulatory issues affecting the UXO problem are most frequently associated with the BRAC and FUDS processes involving the transfer of DoD property to other government agencies or to the civilian sector. When the transfer of responsibility to other government agencies or to the civilian sector takes place, the DoD lands fall under the compliance requirements of the Superfund statutes. Section 2908 of the 1993 Public Law 103-160 requires adherence to CERCLA provisions. The basic issues center upon the assumption of liability for ordnance contamination on the previously DoD-controlled sites.

The environmental cleanup of the former VNTR on the eastern sector of Vieques Island began on January 10, 2000 under the Resource Conservation and Recovery Act (RCRA) 3008(h) Consent Order. The RCRA framework was established by Congress to address environmental problems due to hazardous waste remaining on transferring properties. On April 30, 2001, the U.S. Navy transferred approximately 4,000 acres of the former NASD to the municipality of Vieques; 3,100 acres to the U.S. Department of the Interior (DOI) Fish and Wildlife Service; and 800 acres to the Puerto Rico Conservation Trust. On May 1, 2003, the Navy transferred an additional 14,573 acres of the former VNTR on east Vieques to the U.S. Department of Interior (DOI) to be added to the Vieques National Wildlife Refuge, Figure 1-3.[1]

In 2003, the Navy conducted a munitions survey of both Bahia Corcho (Red Beach) and Bahia de la Chiva (Blue Beach). These beaches were then officially opened to the general public. They were temporarily closed again in 2004 after storms washed munitions items from offshore onto the public beaches.[2]

In 2005, the U.S. Environmental Protection Agency (EPA) placed the former VNTR and NASD areas of Vieques on the National Priorities List (NPL) thus designating these areas as "Superfund" sites. In addition to the environmental sites, there are 62 additional potential sites with munitions and explosives of concern (MEC) remaining on the former VNTR. Continuing cleanup on the site is being conducted under CERCLA guidelines following a Federal Facilities Agreement, which was developed and signed by the parties.[3]

The Navy conducted a *Preliminary Range Assessment and Phase I Extended Range Assessment* in 2005 to gather data on the quantity and types of munitions remaining on the site to prioritize sites for further study and to identify high risk sites that might require time-critical removal actions.[2] In April 2005, a Time Critical Removal Action (TCRA) began. The beaches and other high priority areas in the LIA were investigated and UXO items were identified and removed.

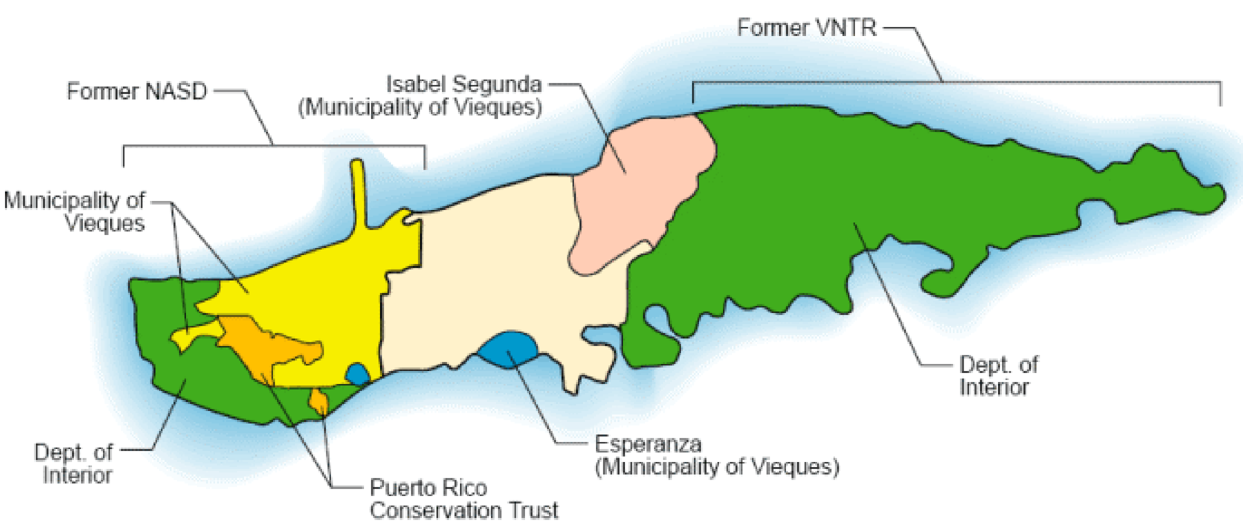

Figure 1-3: Control of Land transferred by the U.S. Navy on Vieques, Puerto Rico

2.0 TECHNOLOGY

2.1 Technology Development and Application

The MTA technology development had its genesis in SERDP Project UX-1322.[4] The SERDP project involved a concept study to evaluate the feasibility of various sensor deployment options and an engineering study to develop preliminary designs for the sensor array platforms and the requirements for a tow vessel. In addition, we carried out both first principles studies of the performance of EMI arrays in salt water and empirical parameterization studies using inert ordnance and EMI breadboard coil systems to validate our predictions.[5]

The system concept study was carried out in conjunction with Vehicle Control Technologies, Inc. (VCT). We considered a wide range of platform design concepts, and evaluated their potential performance against the top-level requirements in both static and dynamic hydro-code modeling studies. Design concepts included bottom-following platforms (sleds or roller designs), towed submerged platforms (with solid booms or flexible cables), and hybrid platforms dynamically suspended from a towed pontoon platform.

The preliminary design resulting from the concept study was a wing-shaped fiberglass structure designed to be towed from a position well forward of the wing using a flexible tow cable. Pitch stability, Figure 2-1, is provided by the (yellow) wing extensions. Weighted skids on the bottom provide stability to ward off inevitable bottom collisions. Roll and depth control are provided by the elevators (red) on the trailing edge of the wing extensions. The elevators are controlled by two actuators (gray). The EM array is embedded in the structure; the magnetometers are in bottles (blue) that extend above the top of the wing surface and are covered by cowlings.

The concept design is shown in Figure 2-2. Here we have included general descriptions of the positioning sensors that are required to derive the coordinates of the individual sensors. The precise descriptions of the different positioning sensors are discussed in various SERDP project reports and in the Project Final Report.[2] The most sensitive measurement that must be made is the angle that the tow cable forms relative to the long dimension of the tow vessel, ψ_c, in Figure 2-2. The contributions to the complete positioning error budget were treated in a separate study, which was continually refined as the individual component choices were made and their performances evaluated. At the end of the SERDP Project, it was our prediction that we would be able to locate the sensor positions in the horizontal plane to <15 cm and in the

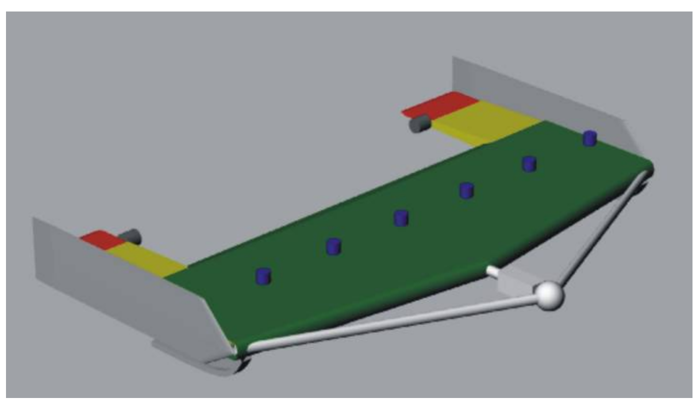

Figure 2-1 Perspective drawing of the 4-meter sensor platform concept.

vertical plane to <20 cm using this design.

The final product deliverable for the SERDP Project was the Program Final Report.[5] Each of the studies listed below is an internal report documenting the project developments. The documents are available in association with the Project Final Report:

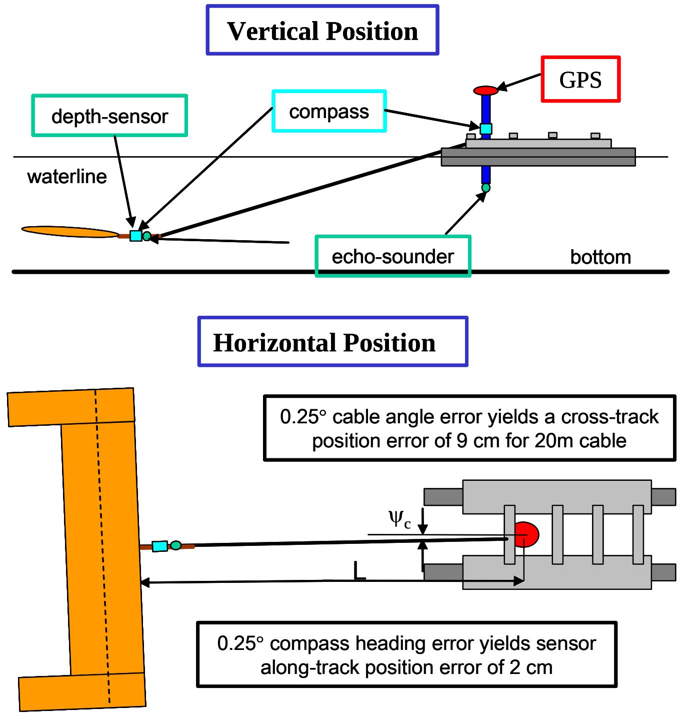

Figure 2-2. Sensor platform deployment concept resulting from SERDP Project UX-1322.

- "Modeling of Electromagnetic Response of EMI Sensors Employed in a Salt Water Environment," AETC Report, 01/04;
- "Concept Design for a Marine UXO Sensor Platform," VCT Tech Memo 02-06;
- "Concept Design for a Marine UXO Sensor Platform – Autopilot for 2-m and 4-m Concept Vehicles," VCT Tech Memo 03-01 and VCT Tech Memo 03-02;
- "EM68 – Marine EMI UXO Detector Project Development Interim Report," Geonics Report, April 2003;
- "Report of Overlapping Receiver Coil Study," Geonics Report, 29 August 2003,
- "EM68 – Marine EMI UXO Detector Project Development Report," Geonics Report, September 2003;
- "EM68 Instructions for Control & Logging Program, Geonics Report," September 2003; and
- "Evaluation of Performance and Capabilities of the DIDSON Imaging Sonar," AETC Report, 12/03.

The majority of the actual development work on the Marine Towed Array took place during the ESTCP Project MM2003-24.[6] Structural Composites, Inc. (SCI) joined the effort at the beginning of the ESTCP project. Working with the sensor platform concept designs and the results of the system hydrodynamic performance modeling, we developed a preliminary engineering design. This design was submitted to a Finite Element Analysis to validate the predicted system performance and evaluate the limits of the mechanical structure. Following the final system design review, SCI was contracted to produce the sensor platform.

We contracted with a separate firm, Ocean Marine Industries, to design the cable system for towing the sensor platform and to design the sensor interface container. The latter component is a waterproof cylinder that mounts on the sensor platform. Using underwater connectors, this unit

serves as a bulkhead interface, mating all of the sensor leads on the sensor platform to the tow cable electrical input connectors. In addition, this container houses a magnetic compass, the Honeywell IMU, and some printed circuit amplifier boards.

The selection of the individual system components either flowed logically from the requirements developed in the modeling and engineering design studies, or resulted from testing of component performances using borrowed or rented components. In several instances, it was necessary to evaluate the interaction between the components, such as the actuators/cables and the magnetometers, when they were both operating.

Figure 2-3 shows a CAD drawing of the engineering design plan approved for Structural Composites to fabricate. To improve the sensitivity of the EMI system, the receiver coils were increased in size to a full 1 m in width.

Figure 2-4 shows an image of the entire structure floating in the water beside the pontoon boat. Figure 2-5 shows another image with the hatch covers removed. In Figure 2-5 several of the sensor components are identified.

For the tow vessel, we chose a 30 ft long triple pontoon boat manufactured by Crest, Figure 2-6. This is the maximum width boat that can be transported over the road without special wide load permits. A 140 horsepower outboard engine was chosen for propulsion. We had most of the furniture stripped from the deck and we removed the deck railings on the forward half of the boat so that the sensor platform could be stored and transported on the deck. A marine winch was installed on the deck to lift and deploy the sensor platform. Marine hardware was installed to serve as tie-downs for the instrument racks and the generator. Mounting fixtures were designed and built for the tow point fixture, the GPS antennas, the depth sounder, and the imaging sonar.

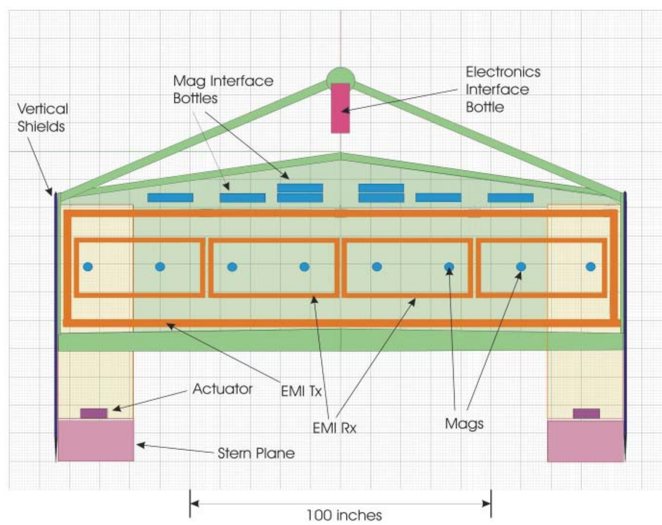

Figure 2-3. Schematic drawing of the marine sensor platform.

The number of sensor systems operating and the complexity of the data streams far exceed any of the previously-developed MTADS arrays. This requires that we have multiple computer systems on board, multiple data racks to accommodate them, and the full-time attention of a technician to monitor the data flow, Figure 2-7.

Figure 2-4. The assembled sensor platform is shown floating beside the tow boat.

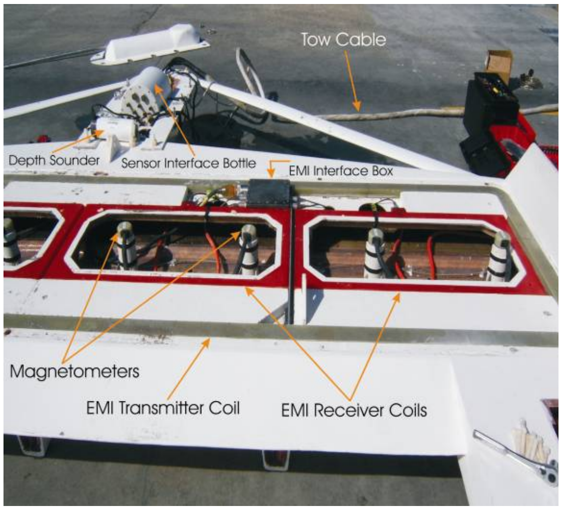

Figure 2-5. The marine sensor platform is shown with the hatch covers removed.

The Didson Imaging Sonar and the Geonics EM68 units were provided with independent GUIs to control their setup, operation, and data recording. These Windows-based systems were too complex to attempt to integrate with our Geometrics Maglog-based Data Acquisition System. We adapted the Didson and Geonics units to accept a GPS time stamp for their recorded data streams. This assures that we can correlate the multiple data sets with each other during analysis. Because it was also necessary to monitor these systems in real time, their data logging displays were set up on the computers, which can be displayed by the data technician as the data are recorded, Figure 2-7. Monitoring all of the data streams, in addition to the platform attitude requires the use of split screens.

Figure 2-6. The tow vessel. The generator is mounted forward, and the electronics racks are being assembled near the port rail.

The pilot display system, Figure 2-8, is mounted on the console to the right of the driver. It is very similar to that developed and implemented in the Airborne MTADS system for the helicopter pilot. The survey tracks are developed, based upon the survey dimensions and the chosen track spacing, and loaded into the display computer. The computer receives the GPS position, heading, and velocity updates, which it uses to plot the survey course over the survey grid in real time for the driver.

Figure 2-7. All sensor data are recorded by the computers in these data racks mounted across from the drive console, near the port

The primary DAQ computer operates a version of the Geometrics Maglog software adapted for this application. Maglog has been the primary DAQ GUI for all prior MTADS platforms. The sensors from the marine platform, except the EM68, are recorded in this utility. Additionally, the GPS data and data from the depth sounder are recorded using this GUI.

A new GUI that we developed to allow us to control and monitor the sensor platform behavior was extensively described in the SERDP UX1322 Final Report.[4] Three primary operational control algorithms were developed for the sensor platform GUI. The first allows us to operate the platform at an operator-specified depth below the surface. The second mode is designed to operate the sensor platform at a specified height above the bottom. The third mode is referred to as the Emergency Rise mode. This can either be called from the keyboard or automatically invoked by pressing the Emergency Rise Button on the electronics rack console panel. In this mode, the elevators are driven to their full up stops and held there until the platform ascends to 0.5 m below the surface. This mode is intended for use if we observe a bottom obstruction that is likely to cause an impact with the sensor platform.

Figure 2-8. The pilot display screen was mounted in front of the captain on the flying bridge of the Coral Queen.

In case of a severe impact of the platform with some bottom structure, we have designed and installed a breakaway link in the tow cable, which will part at 1,100 lb tension. It is shown in Figure 2-9. The electrical connectors from the tow cable to the bulkhead connector at the rear of the boat are designed to part at 50 lb; these cables can be wet re-mated. We also installed a spring damper system connecting the tow cable to the weak link. This reduced the frequency of breaks in the weak link caused by rough seas; but still allows the weak link to break if an impact occurs.

Figure 2-9. The tow point, mounted at the rear of the boat supports the master GPS antenna located on the mast. The digital encoder (yellow) measures the angle of the tow cable relative to the boat heading. The weak link cable is located between the shackles at the end of the tow arm.

Figure 2-10 demonstrates the sensor platform response to commands from the autopilot. These data were taken during shakedown tests of the system before the first system demonstration was undertaken. The top panel shows the response of the sensor platform to command changes in depth while using the 16 m tow cable. In general, the depth changes (by either 1 or 2 meters) in response to

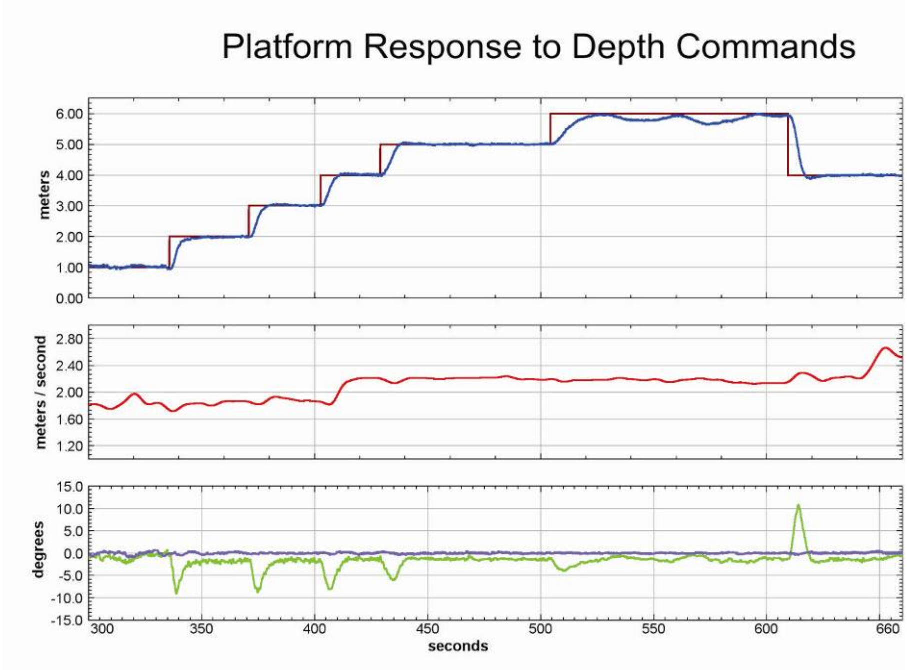

Figure 2-10. Sensor platform responses to autopilot commands.

command changes are completed within about 20 seconds. Except at depths >5.5 m the platform maintains the commanded depth within about 10 cm. The system performs similarly when operating in altitude (above the bottom) mode. The center panel shows the vessel speed. At about 420 seconds, the speed was changed from 1.8 m/s to 2.2 m/s. Short term minor changes in speed are responses to depth command changes or responses to wind gusts. The bottom panel shows the platform pitch. For commanded depth changes of 1 meter the platform typically pitches by 5-7 degrees until the new depth is approached. For 2 meter command changes, the platform pitches by about 12 degrees briefly. The purple trace in the bottom panel shows the platform roll. Typically, the platform roll is maintained neutral within a few tenths of a degree.

To survey near shore areas, we used an array of three 858 magnetometers mounted in the bottom of a flat bottom fiberglass boat. Plywood, dimensional lumber, and brass or silicon-bronze screws, were used to construct a jig to hold the magnetometers and GPS sensors. A similar setup was used during the demonstration in Duck, Figure 2-11. This method was successful at surveying areas where the MTA platform could not be used. The flat bottom boat allows areas near the shore, which are inaccessible by the MTA platform to be surveyed.

Figure 2-11. The 3-magnetometer array, GPS equipment, pilot guidance system, and data acquisition computers are shown mounted in the survey boat.

Prior to the Puerto Rican demonstrations, the MTA had been deployed at three large-scale demonstration surveys. The first full-scale demonstration of the MTA took place in the Currituck Sound offshore from the former Duck Naval Target Range. More than 300 acres of the Sound were surveyed using the magnetometer and EM arrays, a target dig list was prepared, and 100 targets were dug from the sediments at water depths of 1-4 meters. 50% of the recovered items were ordnance. The Final Report of this demonstration provides extensive detail about the performance of the system at this deployment.[7]

The second demonstration took place in June 2006 in Ostrich Bay adjacent to the former Naval Ammunition Depot – Puget Sound. 100 targets from the MTADS target analysis were investigated by EOD divers from the Bangor Det operating in conjunction with the NEODTD. The Final Report[8] of this demonstration provides details on the performance of the system during this demonstration.

The third demonstration occurred in August through October 2006 at the Former Erie Army Depot, Ottawa County, OH. The Final Report[9] for this demonstration provides the detailed performance of the system at this location. This UXO survey design employed widely-spaced survey transects (160-320 m). The entire area sampled by the transect survey was more than 50,000 acres. Targets with signatures contained within the 5 m survey track were analyzed and a target dig list was prepared. UXO-certified divers from EOTI investigated more than 250 targets from the dig list. Of the identified targets, the majority were intact ordnance, mostly projectiles of varying sizes that had been fired during proof testing operations.

2.2 Advantages and Limitations of the Technology

The MTA system offers the first efficient and automated modern UXO survey capability that can provide fully geo-referenced survey products to support shallow water UXO clearance operations. As it is constructed, the Marine Towed Array is a very complex R&D system. It is likely too electronically complex, too heavy, and too expensive to be a competitive commercial instrument as it is currently configured. However, we have very effectively (and reasonably efficiently) completed 5 relatively wide area surveys with the MTA platform. In each of these demonstrations except the first at Duck, the survey conditions significantly exceeded the operational limits that the system was designed to operate in. The most challenging of these were associated with the water depths (2 times the design limit) and the sea state and weather conditions that the system was designed for. On Lake Erie and at Vieques we managed to carry out surveys under conditions significantly exceeding Sea State 2. Adapting to these challenges has required that we make substantial system changes “on the fly.” These include extending the tow cable length, buying and installing a stretchable member between the tow point and the weak link to damp G-forces from vessel pitching, replacing actuator controllers (designed for greater water depths), and chartering vessels of opportunity (and adapting and installing the MTA system on the charter vessel to allow work in heavier seas.

Unfortunately, the EMI sensor components, after operating successfully in the shallow waters at Duck, never were successfully deployed again. This was in spite of redesigns by the

vendor that were intended to fix the system shortcomings. In each deployment there was a failure of either the system underwater connectors or the system underwater interface module.

The MTA system requires the use of an improved boat launch ramp to deploy and recover. In many marine areas associated with former ranges, this is a problem. The system must either be moored in the survey area overnight, or transported from the docking area to the survey area each day resulting in significant losses in survey time. In the Duck survey this resulted in 2-3 hours of lost survey time each day deploying and recovering the system. After several survey days we decided to moor the equipment in the survey area overnight.

During the Ostrich Bay survey, the system was moored within the survey area resulting in minimal survey time lost. Ferrying times were only those required to move personnel from a marina (about 5 miles) to the mooring area using the fast chase boat. The demonstration on Lake Erie required ferrying the survey system to distant transects (up to 16 miles off shore) resulting in up to 4 or more hours of lost survey time each day when working far from shore.

Ferrying time during the Vieques demonstration was even more problematic than the earlier demonstrations. The nearest boat launch ramp was approximately 11 miles from the survey area. A chase boat was used to ferry people to and from the survey vessel, which was permanently moored within the relatively protected bay that was being surveyed. The initial deployment from the launch ramp to the survey area took more than half a day. The maximum speed that the platform could be towed, even in 2-foot seas, was <2 kts. On about 30% of the potential survey days the seas were so rough (>7 ft) that we could not make the 11 mile journey from the Esperanza dock to the survey site. On two separate occasions when the sensor platform had to be moved, the seas were so high (for several days) that we had to resort to chartering a sea-going barge to hoist the platform and transport it to the dock. Each of these charters cost ~$15K. 24 hour/day mooring of the MTA platform in the Bahia Salinas del Sur required that we hire overnight security personnel to remain on the vessel each night.

In any future version of the MTA sensor platform it is imperative that it be designed so that it can be transported on the deck of the tow vessel and be deployed and recovered “at sea.” This is even more important if future platforms are to be used for commercial applications. The cost of “in place” crews who cannot work because the equipment cannot be deployed or because they cannot be commuted back and forth to and from the job site expeditiously is very expensive and diminishes productivity.

3.0 PERFORMANCE OBJECTIVES

The primary objectives of this demonstration of the MTA focused on deployment of the system using a charter boat of opportunity as a tow vessel, achieving an acceptable survey production rate (in a near open ocean environment), and detection performance with minimal missed survey areas in Bahiá Salinas del Sur, Bahiá Salinas, and (time allowing) other nearby areas mutually agreed upon by ESTCP, NAVFAC Lant, and SAIC Incorporated. As the demonstration evolved, all survey operations took place within the Bahiá Salinas del Sur and areas immediately outside the mouth of the Bay. There was insufficient time to move the equipment to other potential survey areas. Figure 3-1 shows an area perspective from a low altitude aerial photograph.

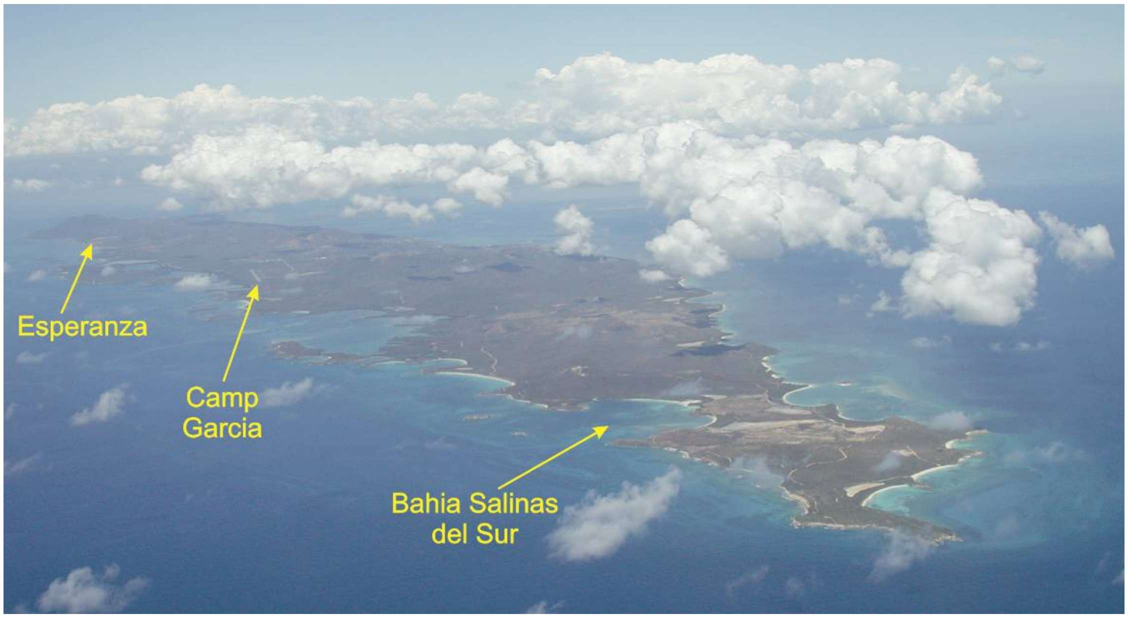

Figure 3-1. An aerial photograph of Vieques is shown with the location of the proposed survey area noted.

The surveys were conducted entirely using the MTA magnetometer array in and near the Bahiá Salinas del Sur. The EM array irreversibly failed when it was first activated on site. The MTA system as deployed (following redesign to accommodate deeper water and higher sea states), is capable of surveying in water depths of 4.5-35 ft. Depths greater than ~24 ft require reduced survey speeds. Surveys in water deeper than ~30 ft were conducted (with the array towed farther above the bottom) to detect larger objects (e.g. GP bombs). More than 95% of the surveyed area in the Bahiá involved water depths of <35 ft. Many parts of the Bahiá known to contain high MEC concentrations were too shallow to survey with the MTA. The Carolina skiff that we adapted for shallow water operations, proved to be invaluable for working these shallow areas. These survey areas comprised about ~20% of the total survey area. The skiff technology development and the skiff survey results are described in separate sections of this report. It was a significant advantage to us that we could operate the skiff survey and the MTA survey

platforms simultaneously. This was made possible because of the availability of SAIC-owned sensors and GPS equipment which was made available for the demonstration.

We set up the survey coverage design to maximize the overlap with the UXO survey that was recently conducted by NOAA NMSP.[10] The NOAA survey areas that were not covered by the MTA were primarily in waters that were too deep to effectively use the MTA. We coordinated our efforts with the NOAA demonstration manager who was on site during part of our MTA demonstration operations.

We installed a TV camera (with lights) on the survey platform prior to conducting this survey. It was intended to use the images to identify targets that were proud of the bottom. These images could also be used to guide divers to the correct target in future intrusive operations. The TV system was unfortunately destroyed during a period that the Coral Queen was unoccupied because the attendant on the vessel had been removed by UXO contractors who were conducting demolition operations on shore. During the 6-hour time period that the attendant was unable to return to the vessel, the Coral Queen dragged one of the moorings prepared by NAVFAC for our use and repeatedly impacted the sensor platform destroying the TV system.

Table 3-1, adapted from the Test Plan[11] shows the quantitative demonstration objectives as presented in the Demonstration Test Plan. Column 3 has been completed based upon the various performance criteria for each objective as measured from the survey data. Similarly, Table 3-2 shows the qualitative demonstration objectives with right column describing the system performance during the survey operations.

An on-site survey operation of approximately 4 weeks was planned and scheduled. Depending upon water depths, surface conditions, weather conditions, and the time required for morning and evening ferrying between the survey site (mooring site) and the dock, we anticipated that 250-400 acres could be surveyed. Intended survey products included mapped data file digital images of all surveyed areas and analyses of all detected targets to provide specific locations (UTM coordinates), estimations of target size, burial depths, and likelihood of being UXO. A log of the survey operations is shown in Table 3-3. Table 3-4 provides a log of the skiff and MTA survey files.

Several (qualitative and quantitative) objectives referenced specific aspects of the MTA survey production rate and the ability to maintain survey quality in high seas and winds and with multiple captains. The relevant issues include station keeping, line keeping, platform stability, survey coverage and missed areas, and hourly and daily coverage rates (Table 3-4). The vessels were chartered from Sea Ventures (a recreational dive support company). The boats were provided with a captain and a mate. The same mate served for the entire demonstration. He was a certified diver who was also responsible for the maintenance and operation of the vessels. He also slept on the tow vessel, providing 24 hour security and he coordinated activities of the tow vessel, the chase boat, and the skiff. Several captains served for varying lengths of time during the demonstration. They were responsible for driving the survey vessel. All were long-term

Table 3-1. Quantitative Demonstration Objectives for the MTA Survey

Primary Performance Criteria	Expected Performance	Actual Performance
Data preprocessing and creation of mapped data files	Accomplish overnight for QA Purposes	All data were preprocessed overnight
Target analysis and preparation of dig lists	Accomplish within 2 weeks of survey	Because no target investigations and recoveries were planned, only spot target analyses were conducted.
Magnetometry survey production rates	6 acres/hr while surveying in the open water areas	MTA survey rates were 5.35 acres/hour. Skiff survey rates were 6.3 acres/hour.
EM survey production rates	6 acres/hr while surveying in the open water areas	No EM surveys were done.
Detection of Calibration targets	All calibration targets will be detected in mag and EM datasets	All 12 Cal targets were dominated by remnant signals. Target 5 was effectively undetectable.
Target location accuracies	±35 cm, overall when surveying with short cable, ±60 cm when surveying with long cable	Target position accuracies could not be evaluated because the Cal targets were not accurately located and no targets were recovered
Survey coverage/Missed areas	In areas intended for complete coverage, >95% coverage will be accomplished.	Actual surveyed areas had >95% coverage
Depth station keeping	Command depth (or altitude) will be maintained within 0.15 m 95% of the time	Command altitude was maintained to <0.15m 100% of the time.
Line station keeping	During acceptable weather, 4 m survey lanes will reduce missed areas to <5%	Sea state 1 conditions effectively never applied. Missed areas were completed by resurvey.

certified captains but none had any experience in piloting a vessel to the continuous sub-meter accuracy graphically presented to them by the pilot guidance display. Most learned to do a good job within a day of driving. A couple never mastered the skill (requiring one of the SAIC staff to drive the vessel). Seas within the bay were typically 1.5-2.5 ft with winds of 5 to 20 knots. The survey vessel turned better (smoother and tighter) to port than to starboard, therefore, most grids were set up to take advantage using a "moving racetrack" (Zamboni) approach.

Surveying was never stopped during showers (or even moderate rain). Overall, the survey coverage and missed survey areas were as good in this survey as in our earlier surveys (in calmer waters and with more experienced boat drivers). The tow vessel (Coral Queen) is substantially larger, heavier, and less subject to winds than the MTA pontoon boat. Hourly survey production rates (based upon the recorded survey files) were similar in this demonstration to those previously conducted. Survey speeds are primarily limited by the survey depth of the platform. They are secondarily limited by the wave heights. The use of the flexible cable between the tow arm and the tow cable improved the system performance in heavier seas by reducing the G-forces on the weak link resulting from pitching of the tow vessel crossing swells. Survey production rates are based upon the electronic survey data files, which record down-the-track progress as a function of time. Survey coverage and missed survey areas are evaluated from "course-over-ground" (COG) plots Figure 3-2 and the preprocessed mapped data files, Figure 3-3.

Table 3-2. Qualitative Objectives for the MTA Survey

Operation	Objective	Measurement Metric	Performance Evaluation
Logistics and Support	Pre-establish necessary support logistics	Time lost during demonstration to correct deficiencies	Logistics time lost primarily due to vessel breakdowns and missing captains. All help required access to the big island
	Efficient boat and survey platform deployment and recovery	Time lost at the beginning and end of each day to deploy and secure the system	Platform secured on survey site. Several days lost to transport platform for repairs and demobilization.
	Provide system support and communication while at sea	Lost survey time to correct problems	Cell phones unreliable on site. Only contact by radio with UXO contractors on the LIA.
	Provide onshore logistics to support data processing and data products	Timely processing of survey data for quality assurance	All data processing completed in a timely manner.
Equipment Component Performance	Platform attitude and position control to support precise navigation and location requirements	Number of breakdowns and work stoppages because of equipment failures or lack of spare components.	Except for EM, the MTA equipment was reliable. All repairs made from spares. Charter vessel breakdowns were a problem.
	Efficient performance and integration of ancillary components	Time lost or survey integrety compromised because of GPS, DIDSON sonar, boat-mounted depth sounders, or the pilot guidance system performance	These components worked well. Exception was the destroyed TV camera.
Survey Operations	Maintain consistently high survey production rate.	Will be measured and reported as hourly and daily survey rates and also fraction of the day actually taking survey data	While on the survey site, production was good. Commuting to and from the site caused many delays.
	Maximize coverage area and minimize missed areas	Will be measured using course-over-ground plots	Given the typical sea state, the coverage was excellent and the missed areas mimimized.
	Achieve detection goals for individual targets	Sensor detection will be evaluated against emplaced targets	Emplaced targets were dominated by remnant moments. No info acquired to demonstrate detection sensitivity.
	Pilot guidance system provides capability to achieve survey goals	Performance will be evaluated with course-over-ground plots in varying sea states and weather conditions	Pilot guidance worked well. Several captains were taught to use it with minimal problems.
Data Acquisition Performance	Efficient integration of all components supporting the pilot guidance display, the platform autopilot, and the data acquisition system	Will be evaluated by the ability to lay out and survey to a prepared grid, by the extent and severity of track misregisterations, and by the ability to fly the platform on a straight and level course	Performance was excellent.
	Conduct an efficient EMI survey	If performed, EMI survey performance and detection capability will be measured against the magnetometer survey performance	No EMI surveys.
	Successful performance of the imaging sonar	Performance will be evaluated imaging areas around piers and moorings	Imaging sonar was not used.
Data Products	Overnight data preprocessing	Preprocess and correct survey data	Completed on time.
	Timely target analysis	Target analyses completed for preparation of reports and to support intrusive work	There was no intrusive work. Analysis completed to allow report and future possible cleanup work.
	Timely preparation of dig products	Prioritized dig lists prepared as described in Work Plan	Target lists have prioritized evaluations.

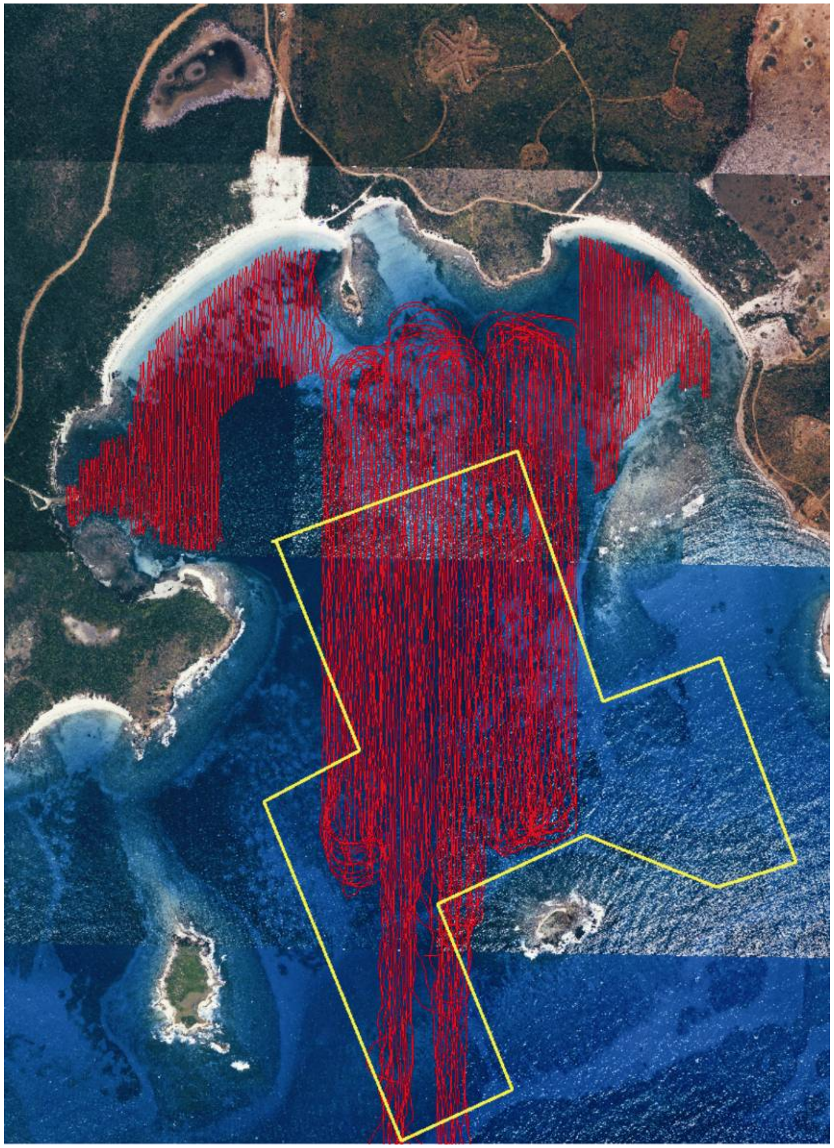

Figure 3-2. Course-Over-Ground plot for the MTA and part of the skiff surveys.

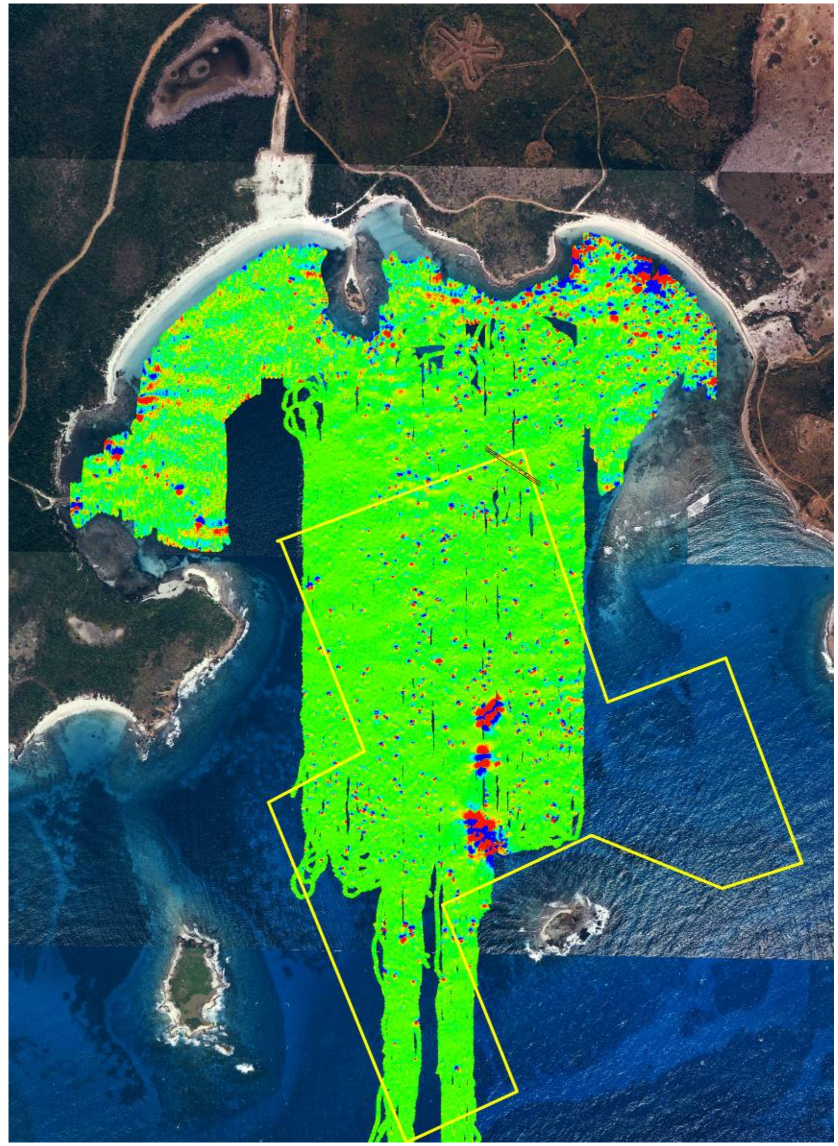

Figure 3-3. Magnetic Anomaly Image map of the MTA and skiff surveys.

A group of 12 calibration targets were installed by NAVFAC Lant contract divers within the survey area. The calibration targets consisted of 18 in long (3/8 in diameter) sections of rebar. These were installed by pushing the rebar sections vertically into the sediment (sand) along a straight line with an intended spacing of about 30 ft. The positions of the individual rebar sections were measured using GPS survey equipment and provided to us for calibration purposes. The results of the calibration line surveys are discussed in Section 5.4.3.

Because there were no target investigations or recoveries following the MTA survey, the accuracy of the reported MTA target positions (a quantitative objective) were intended to rely on only the survey of the calibration targets. Our analyses (after many survey passes over the calibration targets) indicated to us that the positioning errors reported by NAVFAC Lant for the individual calibration targets was several times larger than the errors in our regular survey and analysis position accuracies. This is discussed further in Section 5.4.3.

The section below addresses issues associated with qualitative objectives relating to data acquisition and survey operations. Survey quality control (data integrity and survey coverage/survey quality) is primarily the result of two processes. Within the data acquisition process on the tow vessel, there exist numerous real-time data information displays (platform pitch, roll, and yaw, platform altitude and depth, heading, etc) and streaming graphic displays of the magnetic sensor data (displaying signal intensities and noise levels). These displays verify the data integrity of the sensor data streams and the platform/autopilot control integrity. Data are typically recorded for about one hour periods before a file is closed and a new file is started (Table 3-4). This improves the efficiency of the second quality control step – the preprocessing of the data.

Data preprocessing typically takes place in an office or hotel room environment. Because real-time communication (cell phone) from the survey vessel to the hotel was not possible, data preprocessing was done by the data technician on the survey vessel. The Coral Queen had a semi-enclosed cabin, which allowed this to take place in a sheltered (if not quiet) environment. The preprocessing includes several data fidelity checks and data clean-up steps. More importantly for this discussion, course-over-ground (COG) and magnetic anomaly image maps area created as part of the preprocessing, see Figure 3-2 and 3-3. These maps are used to determine survey coverage and missed areas. Endpoint survey coordinates are developed by the data processor and provided to the pilot guidance computer to define survey lines to fill in missed survey areas. Survey coverage was excellent by both the MTA and the skiff survey platforms, Figure 3-3. The final processed survey data that was provided to the target data analyst was equivalent to the data taken on previous survey demonstrations.

The discussion below addresses the qualitative objectives related to creation of survey data products. Raw data were downloaded onto DVDs from the data acquisition computers following completion of a data file. These were provided immediately to the data tech who was onboard on the Coral Queen. The data technician was able to inspect the data immediately. During the first couple of survey days the data technician primarily worked on establishing the data correction and processing procedures (yaw and layback adjustments, developing the

correction parameters for the leveling and smoothing filter functions, and establishing the site mask and coordinates for the eventual complete survey. Following these initial steps, the data tech typically completed the survey data preprocessing in near real time. Because no targets were scheduled to be investigated or recovered during the survey period, comprehensive target analyses were not carried out during the survey. Spot analyses were carried out to verify that the data fitting routines were working correctly and that the fit target sizes and burial depths were appropriate with the ordnance that we expected to find in the Bay. Early survey passes were done over the wreck of the Killen to determine the extent of the scattering of the wreckage and the intensities of the signals associated with the ship debris. Major components of the ship are scattered over an area of ~75 m wide (East-West) by about 300 m in the North-South direction. These are apparent in images that are presented in other sections of this report.

Another data issue relating to target analysis that was considered relates to the significant side-to-side rolling motion of the tow vessel because of the substantial ocean swells. This rolling motion had a minimal effect on the submerged sensor platform movements or its stability, but had a significant effect on the data presentations because the side-to-side rolling motions were incorporated into the GPS positioning measurements, which were then translated into the mapped data files used by the analyst to fit targets. This effect is shown in **Figure 3-4**, which is a screen clip from the MTADS DAS anomaly fitting routine from some of the earliest data taken. Because this rolling motion is an artifact in the anomaly fitting data we ultimately developed a smoothing routine to minimize (but not remove) its effect. The effect of the rolling motion is often significantly different for adjacent survey lines because the vessel was often quartering into the waves going into the wind and being overtaken by the waves when moving in the other direction. Tests showed that there was only a small difference in the target fitting results with and without the use of the smoothing filter. The primary differences were manifested in the apparent fit quality, not on the fit position or in the target physical parameters (position, size, depth).

The discussion below addresses the qualitative objectives related to the logistics and support objectives. Arrangement of logistics requirements on either Vieques or the main island of Puerto Rico was difficult except when dealing with vehicle rentals or chain or resort hotels. The only way to effectively make logistics arrangements was to get our island subcontractors to make the arrangements (or to make them ourselves in face-to-face arrangements on the spot). Virtually all equipment, supplies, or even personnel changes for the charter vessels required ordering from the main island and transport by ferry to Vieques; even this was not always successful. Overnight express shipping for small item deliveries from Puerto Rico to Vieques worked as long as the item being shipped was small enough to be carried by the small commuter flights between the islands.

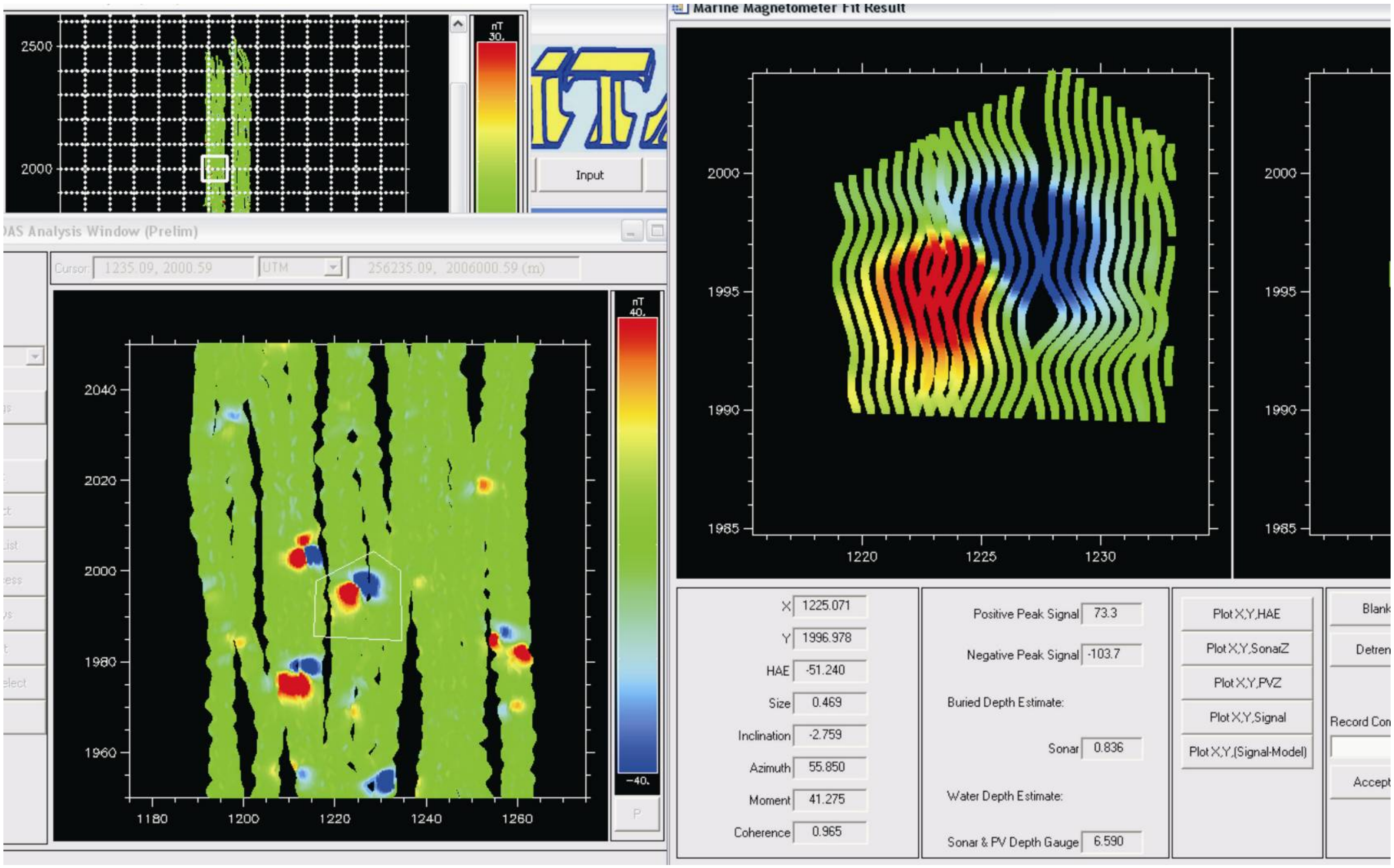

Figure 3-4. This screen clip from the MTADS DAS shows the isolation of a target for analysis and the target fit. The rolling motions of the tow vessel are apparent in the images.

Our morning and evening commutes to and from the survey site required travel by small boat from Esperanza to the Bahia (more than an hour in each direction). Several survey days were lost because seas were too high to make the trip. It was only about a 12 mile overland trip from Esperanza to the beach on the Bahia. However, we could not make satisfactory arrangements with the Navy security offices at Camp Garcia that would allow us to come and go without checking through security twice a day and waiting for escorts to accompany us to and from the beach. We did this a couple of times in emergencies, but it invariably required one and a half hours to complete the 8 miles from the security gate to the beach.

4.0 SITE DESCRIPTION

4.1 Site Selection

ESTCP and SAIC explored several potential survey sites to conduct an additional MTA demonstration. The offshore areas associated with ranges on the eastern end of Vieques Island east of Puerto Rico offered a good opportunity. Figure 1-1 shows the island of Vieques. The former range areas involved approximately half of the island. The actual MTA survey area in the Bahiá Salinas del Sur is shown near the eastern end of the island. This Bay lies almost entirely within the Live Impact Area used primarily for Naval and aerial bombardment. The bay also lies within the range fans of some of the land-based firing points (not shown in Figure 1-1). Figure 1-2 shows an aerial photograph of the Bahiá and the two small islands guarding the entrance to the bay. Many of the target impact areas are also shown on land near the top of the image. Extensive ranges, which occupy the eastern half of the island, were active for over 50 years. Range fans from onshore firing points stretch well offshore in many areas. Many of these areas were also used for aerial bombing and as impact points for projectiles fired from US Naval vessels. The entire area has been decommissioned; some of the land-based impact areas are currently being cleaned of UXO in preparation for returning the lands for non-military uses. It is known that many of the bays and near-shore areas have significant UXO contamination, Figure 4-1. Several years ago, extensive areas of several beaches (not including the Bahiá Salinas del Sur) were cleaned of UXO by Navy contractors for use by tourists and local citizens. Following storms these beaches were contaminated again by UXO migrating onto the beaches from offshore.

Figure 4-1. Examples of projectiles fired from ships and bombs and rockets dropped from aircraft that lie in bay within the LIA.

NAVFAC Atlantic Division is the command that is managing the cleanup activities on Vieques Island. In December 2006 Christopher Penny and Johnny Noles of NAVFAC Lant and some of their onsite contractors from CH2M Hill supported a visit by members of SAIC to explore the possibility of conducting an offshore demonstration of the MTA in some of the more protected areas of island that have expected UXO contamination. We departed from the dock at Esperanza on the south shore of Vieques and circumnavigated most of the island in a small boat. In particular, we explored the Bahiá Salinas del Sur on the south side of the island and the Bahiá Salinas and Bahiá Icacos on the north side of the island both of which also lie within the LIA.

The demonstration survey took place within the Bahiá Salinas del Sur and areas just south of the mouth of the bay in open waters. The area of the bay is approximately ¾ by ½ nautical miles with water depths up to slightly more than 30 feet. The bottom of the bay consists of areas of open sand, areas covered by marine sea grasses, and coral reefs. The coral tend to be in fringing clusters around islands and along the shoreline. Areas of coral in the main part of the bay are typically associated with solid bottom structures (such as the components of the wrecked

Killen) or piles of dead coral rubble (likely created by earlier ordnance detonations). On sunny days the coral was almost always visible from the flying bridge of the survey vessel. Additionally, the vessel captains were invariably familiar with the reefs because their normal activities included diving with recreational dive customers on the reefs. Many of the fringing coral areas in shallow water were surveyed using the flat bottomed Carolina Skiff.

Tides were not an issue during the survey. Tidal charts for June 2007 indicated that a maximum high-low tide change of less than 1.5 ft. The tides were not a factor in survey planning.

The closest boat launch to the survey site in Bahiá Salinas del Sur was in Esperanza, approximately 11 miles from the survey area. Navigation charts note mooring restriction in the Bahia Salinas del Sur. We requested a waiver to this restriction to allow us to place moorings for the survey vessel during the demonstration. This was denied, however NAVFAC, Lant agreed to have their local contractor install moorings that we could use. They installed three light anchors with buoys that we could use to moor the tow vessel and the sensor platform overnight. The mooring anchors for the survey vessel failed the second day that the vessel was on site, resulting in the loss of our TV equipment. Subsequently, we bought two much larger anchors to replace the light anchors that were first installed.

The sensor platform was initially assembled and launched from the boat ramp in Esperanza and ferried to the moorings in the survey areas. The initial transit time for the vessel and survey platform to the Bahia was more than 4.5 hours. Figure 4-2 shows the semi-improved boat launch ramp and some of the mooring sites in Esperanza Bay. Figure 4-3 shows the Chase Boat temporarily tied up at one of the fishing piers in the Bay.

The chase boat was used to transport personal back and forth between the survey vessel and Esperanza. It was moored overnight in Esperanza at public moorings near the Fisherman's Dock. The transit time between Esperanza and the Bahiá Salinas del Sur was typically 45 minutes to an hour, depending on ocean conditions. There were 3 days during the demonstration when sea conditions were too rough to attempt the 12 mile transit using the chase boat.

We requested that a new GPS control point be established at an area accessible from the beach in the Bahiá Salinas del Sur. The Control Point was established by NAVFAC Lant at a rocky point on the west side of the Bahia near the shoreline. We accessed this point each morning from the chase boat to change the GPS battery. The GPS base station batteries were recharged overnight in the hotel room following survey operations.

Figure 4-2. This image shows the launch ramp in Esperanza. The water was too shallow for Coral Queen access, which required us to launch the platform and tow it to the Queen with the skiff.

4.2 Site History

Figure 4-3. This image shows the Chase Boat temporarily docked at a pier in Esperanza. This was the departure point for the daily commute to Vieques.

A brief top level history of the use of Vieques as a test and training range is included in Section 1.1.2 of this document. Additional information relating to the LIA and to the ordnance history of the Bahia is provided in Section 4.1. Ordnance contamination information is provided in Section 4.4. There are numerous public Web Sites sponsored by the Puerto Rican government, local Vieques citizens groups, and the US Navy that provide extensive and detailed coverage of the historical use of Vieques by US forces, as well as current operations that are ongoing. These sites provide a cross section of opinions and views, as well as a lot of factual information.

In November 2006, NOAA performed a UXO demonstration in Bahiá Salinas del Sur. Their primary work product was a new bathymetry map of the bays on the north and south sides of the island. Results from this demonstration were provided to us as GIS-compatible maps just prior to our MTA survey. The NOAA demonstration plan provided in Ref 6, their Health and Safety Work Plan is given in Ref 13. Figures 3-2 and 3-3 show the planned NOAA survey areas superimposed on our MTA and skiff survey areas.

4.3 Site Geology

There are rocky outcroppings at various places on Vieques indicative of its volcanic origins. However, much of the island, particularly in areas close to the shore, has sandy soils. The two islands protecting the mouth of the Bahia and the chain of hills on the west side of the bay are rocky outcroppings. The remainder of the bay area appears to be sand. As will be shown later when the survey results are presented, magnetic geological formations were, at best, barely detectable in our routine survey presentations. Underlying geological structure is just visible in the skiff surveys along the western and north-western shoreline; it did not have any effect on the target analyses.

4.4 Munitions Contamination

Present day operations on the eastern half of Vieques Island are all cleanup related. To date, all UXO cleanup operations are taking place on land. As of January 2006, operating under a TCRA, 267 acres of the former LIA was surface cleared, including 65 acres of beaches as referred to above. During this process 2,500 intact live munitions and over 125,000 munitions-related items were recovered.[3] Figure 4-4 shows a small stockpile of ordnance that was consolidated during this clearance. Note the large concentration of submunitions (antipersonnel bomblets from cluster bombs).

Table 4-1 provides a summary of the cross section of intact recovered ordnance. This list is probably a reasonable approximation to the ordnance that was expected to be in the Bahiá Salinas del Sur because the land-based range fans, the aerial bombardment targets, and the naval targets all incorporated the Bahia in the target paths to the impact areas.

UXO cleanup operations are continuing on the mainland within the LIA. Individual sections are being cleared of vegetation to allow subsurface ordnance to be detected and recovered.

These operations are described in US Navy Websites. There are currently no offshore UXO recovery operations that have been firmly scheduled.

Table 4-1. List of Ordnance Recently Recovered on the LIA

Bombs	Projectiles/Mortars
AN-M30 (100 lb)	105 mm Projectile
AN-M65 (1000 lb)	155 mm Projectile
M117 (750 lb)	16 in / 50
MK-106 (5 lb)/BDU-48 (10 lb)	175 mm Projectile
MK-23 (Old-Style)	20 mm Projectile
MK-76/BDU 33 (25 lb)	25 mm Projectile
MK-81 (250 lb)	27 mm Projectile
MK-82 (500 lb) and BDU-45	3 in/50 (MK-27, MK-29, MK-33)
MK-83 (1000 lb)	30 mm Projectile
MK-84 (2000 lb)	37 mm Projectile
	4.2 in Mortar
Flares-Pyrotechnics	4.5 in / 38 (UK)
MK-24 Flare (Parachute)	40 mm Projectile
MK-25 Flare (Marine Marker)	5 in Projectile
MK-45 Flare (Aircraft)	60 mm Mortar
	75 mm Projectile
Rockets/Missiles	76 mm Projectile
2.75 in Rocket	8 in Projectile
3.5 in Rocket	81 mm Mortar
5 in Rocket	90 mm Projectile
AT4 Rocket (84 mm)	**Submunitions**
	BLU-77
Grenades	M39
40 mm Projected Grenade	MK-118

Figure 4-4. This image shows a portion of the ordnance collected during 2006 from the 240 acre TCRA in the LIA.

5.0 TEST DESIGN

5.1 Conceptual Experimental Design

5.1.1 Equipment Transportation: An on-site survey operation of approximately 4 weeks was anticipated. Depending upon water depths, surface conditions, weather conditions, and the time required for morning and evening ferrying between the survey site and the dock (mooring site), we anticipated that 250-400 acres could be surveyed. In preparation for the demonstration activities, all MTA equipment (excluding the pontoon boat) was shipped from the SAIC office in Cary, NC to San Juan, Puerto Rico. The equipment (primarily in shipping crates and weather-proof racks) was loaded onto a 45 ft open flatbed trailer. The shipping company transported the trailer by road to Orlando, FL; it was then shipped (below deck) on a cargo barge to San Juan where it cleared customs. The equipment was transported from San Juan to Fajardo where it was off-loaded into a rented box truck at the same marina where the build-out of the chartered tow vessel was taking place. The chartered vessels are described below. From Fajardo, the box truck and the sensor platform on the boat trailer were transported by inter-island ferry to Mosquito Pier on the north shore of Vieques. From there they were driven to the City Park in Esperanza where the platform was assembled, launched and mated with the Coral Queen and towed to the mooring site in the Bahia Salinas del Sur.

A pier, vessel mooring sites, and hotel accommodations were all available in, or near, Esperanza in Vieques. None of these requirements was available any closer to the work site. The overland road distance from our hotel (or from the Esperanza pier) was less than 15 miles, however, because of security requirements, requirements for escorts, and early afternoon quitting times, overland commuting to the site was deemed as unacceptable, except in emergencies. Ultimately, we did use this option on a few occasions when it offered the only afternoon return option from the Bahia or when unexpected situations required us to get from Esperanza to the worksite.

It was decided that using a reasonably fast boat was the best option for the morning and afternoon commute between Esperanza and the Bahia. The deciding factors in the choice of the particular vessel were the charter costs for the chase boat/commuter vessel, the accommodations that the vessel provided, and the availability of an appropriate vessel to charter.

5.1.2 The Support Vessels: During our reconnaissance visit to Puerto Rico and Vieques in December 2006 (see Section 4.1) we visited several marinas and charter boat operators in Fajardo on the main island and in Vieques. We limited our search in Puerto Rico to the east coast of the island (primarily Fajardo) because this is a large city on the eastern end of the island, which also has large marinas and commercial boating operations. We had also done considerable homework on the Web and by telephone. We determined that there were no charter options on Vieques that could provide all the required vessels to support our needs. We determined that our best option in Fajardo was a dive boat charter operator, Sea Ventures. They had offices and operations at three separate cities on the island. They were also highly recommended by the NOAA group who had just completed their sonar bathymetry studies in Vieques.

Because we had decided to commute morning and night using the chase boat, the requirements for the chase boat were increased to allow for more passenger and cargo space and a faster vessel speed. The specifications for the three vessels were stated in the SOW that was provided for quote to vendors. The SOW is included in Appendix B, Charter Boat Options.

The Tow Vessel was specified as at least a 40 ft fiberglass boat with a sheltered cabin and an after deck large enough to accommodate our electronic racks and tow point fixtures. The owner had to support vessel modifications to allow mounting of survey fixtures (tow point hardware, pilot guidance displays, instrument racks, depth sounders, GPS equipment, 5 kW generator, etc). The RFQ issued to Sea Ventures, specified the Coral Queen (or other equivalent vessel). See Figure 5-1 and Appendix B.

The Chase Boat is the support vessel (tender) for the MTA survey vessel. It also provided ferry service back and forth each day for the SAIC and contractor crews from the Fisherman's Dock in Esperanza to the survey mooring points. We required accommodations for 6-8 people, batteries, provisions, and fuel to support the other vessels and the SAIC generator. We specified a cabin to provide protection from the weather and that the boat be capable of operations in 3-5 ft seas. The vessel power requirements were a rugged and reliable inboard engine or twin outboard engines. The chartered vessel, The Dusky, is shown in Figure 4-3.

The Third Vessel was a shallow water survey skiff. We required a flat bottom fiberglass boat with a bottom that is at least 6 feet wide forward of the forward seat. The vessel should be 19-22 feet long with minimal ferrous attachments or other hardware (particularly forward). It should be powered by a modest outboard engine and supported by a non-ferrous gas tank. This vessel was specified as a 19 ft Carolina Skiff or other equivalent vessel powered by at least a 25 hp outboard engine.

The contractor was required to provide all crew (captains and mates) to support his vessels for this operation. He was responsible for providing accommodations and per diem support for the crew. In addition, he was requested to provide overnight security for his vessels and all SAIC equipment and all fuel necessary to support this operation and to deliver it as needed to the survey vessels. The SAIC generators require ~10 gal/day of regular gasoline. The contractor was expected to provide all necessary maintenance and housekeeping support to maintain all vessels in fully operational condition throughout the operation.

Because we also intended to conduct MTA survey operations on the island of Culebra (about 15 mi distant from Vieques) following the Vieques operations, the SOW also specified that the contractor was to support these operations. Furthermore, he was requested to quote per day costs for each vessel depending on whether it was supporting survey operations, was on standby in its home port, or was on standby in a port other than its home port. SAIC also required that the charter contractor extend his additional liability coverage to $5M during his support operations with us. All these conditions are specified in the RFQ/SOW and the Proposal/Quotations provided by Sea Ventures as shown in Appendix B.

Figure 5-1. The Coral Queen is shown outfitted to support dive operations. The rear bench seats and dive tank support fixtures were removed for our operations.

Figure 5-2. The Coral Queen is shown with the tow point fixture and the racks mounted. They were attached to plywood and aluminum plates that were bolted through the deck.

The MTA tow vessel, the Coral Queen is shown in Figure 5-1. Figure 5-2 shows another view of the Coral Queen with the electronics racks and the tow point fixture mounted. Figure 5-3 shows the fitting attachment applied to the port rail to mount the depth sounder. Figure 4-3 shows the chase boat. This vessel, which is powered by twin outboard engines had sufficient room for passengers and cargo, but was mechanically unreliable and was not seaworthy on days with rough wave conditions. On several days we had to rely on replacement vessels provided from Fajardo.

Figure 5-3. This image shows the mounting fixture for the depth sounder.

Figure 5-4 shows a picture of the Carolina Skiff that was outfitted with *ad hoc* plywood fixtures to support the magnetometers and the data acquisition computers after arriving in Vieques. The skiff was towed between Fajardo and Vieques behind the Coral Queen. It was decided that the plywood fixtures would not survive the trip, so they were built (with primitive tools) in Vieques. Figure 5-5 (for size perspective) shows all three vessels side-by-side at the moorings in the Bahia Salinas del Sur.

5.1.3 The Survey Plan: Table 5-1 provides the daily operations log for the entire Vieques Demonstration. The mobilization process was particularly time consuming (June 1-June 8) because of the complex multistep shipping requirements and the necessity to participate in the build-out process to adapt the Coral Queen for mounting our MTA equipment. The demobilization process was much less time consuming (June 27-29). This was largely because the assembled equipment just went into secure storage at the Marina in Fajardo, awaiting our return to mobilize to the island of Culebra.

Figure 5-5. The Carolina Skiff is shown in the Bahia Salinas del Sur.

Figure 5-6. The Coral Queen, the Dusky, and the Carolina Skiff are moored together in the Bahia Salinas del Sur.

The combined morning and evening overwater commuting between Esperanza and the mooring sites in Bahia Salinas del Sur took about 2.5 hours per day (under the best of circumstances). This was exacerbated by the mechanical unreliability of the Dusky (chase boat) and the habit of some of the captains to show up an hour or two late for the morning departure. On several occasions it was necessary to call in an alternate chase boat from Fajardo, which took 2-3 hours to arrive in Esperanza. Three days were lost to weather (sea state that was too high for the commute), or swells that were too large in the Bahia for MTA survey. Two full days of work were lost because ordnance demolitions were taking place on land in the LIA.

5.2 Site Preparation

Our Site and Survey Planning took place starting with our December 2006 reconnaissance trip to Vieques (described in Sections 4.1 and 5.1.2),[11] during subsequent negotiations with NAVFAC Lant concerning support for our demonstration (and constraints associated with ongoing LIA land operations), and with various parties reviewing our Demonstration Test Plan.[11] Additionally, we coordinated our activities with Mr. Jason Rolfe of NOAA who was contemporaneously conducting a bathymetric study of the Bahia Salinas del Sur and other near-shore bays in Vieques.[12]

5.2.1 GPS Control Point: NAVFAC Lant agreed to provide a new control point to support our demonstration survey. Their contractor (CH2M Hill) established the control point on the western shore of the Bahia Salinas del Sur. The coordinates that were provided to us were as follows:
UTM (Zone 20N, WGS 84)
Easting 255526.83 m
Northing 2006176.93 m
HAE -41.59 m

Table 5-1. Daily Operations Log for the Vieques Survey

Date	Operation	Result
Thur. 24 May 2007	Packout	All equipment was crated and packed for shipment.
Fri. 25 May	Ship Equipment	Equipment loaded onto flatbed truck (Crowley) for shipment.
Fri. 1 June	Meet Equipment	Chris & Chet RDU to SJU.
		Equipment arrived in San Juan Port & cleared Customs.
Sat. 2 June	MTA to Fajardo	MTA Equipment arrived at Marina and unloaded.
	Coral Queen	Coral Queen hauled and mounts built for tow point, electronic racks, and GPS mounts.
Sun. 3 June	Buildout	Buildout on Queen and Skiff continued.
Mon. 4 June	Buildout	Jim and Nagi to SJU to Fajardo.
		Buildout continued, Queen launched at day's end.
Tue. 5 June	To Vieques	Three boats sailed to Esperanza, arrive 1300.
		MTA Equipment ferry to Mosquito Pier, rented jeep, then to Esperanza.
		Assembled platform, launched, mated to Queen at mooring.
Wed. 6 June	To Bahia Salinas del Sur	Mated platform, failed actuator & depth sensor. Replaced cable and depth sensor and relaunched.
		Launched Queen at 1100, arrived Bahia at 1630.
Thur. 7 June	Prelim. Work	Dusky dead at dock. Mechanic to fix. Launch at 1100, Bahia at 1200
		Set Base Station. CH2M Hill set moorings & Cal Targets
		Completed prelim. MTA setup, except TV-To-GPS hookup
Fri. 8 June	No Work	Bahia closed for Range Demo.
		Meeting at Camp Garcia, Checked out radio. Agreed to accept direction from Carlton (Navy) or Range Control.
		Flew in used fuel pump for Dusky from Fajardo.
Sat. 9 June	Survey	Mechanic not show to fix Dusky. Sea Tow from Fajardo. Arrive Bahia at 1100.
		MTA data starts 1200. Complete 12 lines.
Sun. 10 June	Survey	Sea Tow at 0700, surveying by 0830. Complete 19 lines.
Mon. 11 June	Survey	New Chase boat (Rusty). MTA data starts at 0855. 3 rain storms. Complete 22 MTA lines.
Tue. 12 June	Survey	Sea Tow Chase Boat again; survey by 1100. 21 lines completed. Mag breakdown.
Wed. 13 June	Broken Down	Chet/Chris to Bahia; MTA has 2 dead mags. Tune up Skiff to take data.
		Jim to Culebra in PM.
		Dusky back to Bahia at 2100 to set anchors; broke shift cable returning.
Thur. 14 June	Broken Down	Dusky still has broken cable.
Fri. 15 June	Broken Down	Retrieve Queen/MTA to Esperanza. Dusky returned to Fajardo for repairs.
Sat. 16 June	Broken Down	Touched up Skiff buildout. Another dead GPS antenna. Worked on Pilot Navigation.
Sun. 17 June	Queen Idle	Ocean waves 10 ft. No go from port.
Mon. 18 June	All Down	Waves 10 ft. No go.
Tue. 19 June	Back to Work	Chartered LCM from Ponce. Carried survey platform to Bahia
		Queen towed Skiff to Bahia. Arrive 1230, mate platform.
		6 passes over Cal Line; MTA survey 6 lines, set new anchors.
Wed. 20 June	Skiff Survey	5-7 ft seas; to BSDS by 0830. Swells 3+ft in Bahia. Too rough for MTA.
		Finished setup of Skiff. Began Skiff survey behind shoals.
Thur. 21 June	Skiff Survey	Queen idle. Skiff surveyed 94 lines on west side of BSDS.
Fri. 22 June	All Idle	LIA bomb demo day.
Sat. 23 June	MTA, Skiff Survey	MTA completes 28 long lines; Skiff surveys 71 lines.
Sun. 24 June	MTA Survey	0830 BSDS. 0830-0930 Maglog Glitch
		Cal Lines, 4 passes. MTA survey 24 long lines.
Mon. 25 June	Skiff Survey	3-6 ft seas, some at 8 ft. Swells 2 ft+ in BSDS.
		Completed 29 Skiff lines. Return overland to Esperanza.
Tue 26 June	MTS Survey	Dusky dead at dock. Overland to BSDS.
		MTA survey 11 west side lines, 6 fill-in lines, Cal. Lines.
Wed. 27 June	Demob	Dusky broken down. Chris/Chet overland to BSDS.
		LCM to BSDS, picked up platform, transport to Mosquito Pier.
		Platform dis-assembled, onto trailer at Mosquito Pier.
Thur. 28 June	Demob	Queen, Dusky (one engine), Skiff to Fajardo.
		Finish packout to depart Vieques.
		McDonald presents brief to Chris Penny & RAB.
Fri. 29 June	Demob	Inter-Island ferry to Fajardo. All equipment into secure storage area. Awaiting deployment to Culebra.
		All SAIC hands to San Juan.
Sat. 30 June	Demob	All SAIC hands to home.

These coordinates were extrapolated from the long-standing control point at the top of the hill on the west side of the Bahia. The hilltop control point has been used by the Navy and their contractors to support all land cleanup operations in the LIA.

5.2.2 MTA Moorings: NAVFAC Lant agreed to install three moorings for us in the Bahia to station our survey vessel and sensor platform overnight. We specified a preferred location within the Bahia and the mooring pattern that we wished to have installed. Two moorings were intended for the Coral Queen; the third (located 15 m to the north or west) was intended for the sensor platform. CH2M Hill installed three small anchors (reportedly they buried them in the sand) and attached lines and buoys to them. The vessel anchors failed on the second day the Coral Queen was moored (while our security personnel had been removed by NAVFAC Contractors because of demolition operations on the LIA). This mooring failure led to the complete destruction of all the TV equipment installed on the sensor platform. We subsequently purchased two new (large) anchors from Fajardo (and installed them at the original anchor sites). These were removed at the end of our survey operations.

5.2.3 Calibration Line: NAVFAC Lant agreed to install a calibration line for our MTA operation. It was agreed that the line of targets would consist of twelve pieces of rebar (3/8 in diameter by 18 in long). We suggested an approximate location for the calibration line and requested that the targets be installed about 10 meters apart in a straight line. We furthermore suggested that they be installed simply by pushing them vertically into the sand. We agreed that absolute location of the calibration line should be adjusted so that it was not installed in an area covered by sea grass, in an area that would disturb existing coral, or in positions that had apparent pre-existing ordnance located. NAVFAC was to provide us with the coordinates of the calibration targets as they were measured (with GPS) when they were installed. The targets were installed by PIKA divers (subcontractors to CH2M Hill). The coordinates as they were reported to us, are given below in Table 5-2. The results of our survey operations on the Calibration Line are described below in Section 5.4.

Table 5-2. Coordinates of the Calibration Lane Targets as Measured by GPS

Rebar ID	Easting (m)	Northing (m)
1	256433.69	2006226.17
2	256424.91	2006229.97
3	256421.41	2006231.86
4	256416.14	2006233.77
5	256412.66	2006237.51
6	256407.41	2006241.26
7	256400.38	2006243.20
8	256398.66	2006246.91
9	256395.18	2006250.64
10	256389.91	2006252.55
11	256386.40	2006254.44
12	256381.15	2006258.20

UTM Zone 20N, WGS84 datum

5.2.4 Site Coordination: We agreed to coordinate our activities with NAVFAC, their contractors, and with Naval personnel while we were working on site. Cell phone communication while in the Bahia was only occasionally possible. We visited the Naval Detachment at Camp Garcia prior to beginning our activities and obtained a radio that was officially used for all Navy and contractor communications in the area. We were able to monitor activities taking place on the LIA with this radio. Some informal communications took place between ourselves and contractor personnel on the LIA. After some misunderstandings, we insisted that all instructions and directions would be issued to us (only) by direct

communication with the Naval (OIC) at Camp Garcia.

5.3 System Specifications

The MTA system design, specifications, and performance have been extensively described in the reports of other demonstrations.[7, 8, 13]

5.4 Calibration Activities

5.4.1 Hardware Calibrations: Most of the components of the MTA are self calibrating, *e.g.* their output is based upon digital counting of frequencies, internal QC analyses are automatically carried out by the GPS components on boot up, etc. All mechanical operational components of the MTA are tested on power up. Internal diagnostic routines are run and presented as displays for each of the magnetometers during their warm up. Magnetometer output readings are available both digitally and as waterfall displays at all times during data taking. If there are noise problems or offset problems associated with the individual units, they area visible in the displays. Continual updates from all the sensors on the sensor platform are displayed digitally, as are the readouts of the platform altitude, pitch, roll, and yaw. The Pilot Guidance computer displays in real time the system position relative to the planned survey grid, the direction and distance off course, the vessel heading, the water depth (and its rate of change), the distance and predicted time to the end of the current survey line, etc. At any time during the course of survey operation we were never more than a few minutes away from the 12 installed targets that were placed in the Calibration Line in the center of the Bay. If any aspect of the operation was in doubt we could just rerun a pass over the calibration targets.

5.4.2 Data Calibration: At the time the survey took place, there were no plans to investigate or recover any of the targets discovered or analyzed during the course of this demonstration.[11] Never-the-less we carefully prepared for this survey, assuming that at some future time our survey data and analyses might be used to investigate or recover the anomalies that we report. The protocols described below were followed to assure the fidelity of our data and analysis products.

We recorded all relevant data strings from the GPS antennas mounted at the bow and stern of the tow vessel and the survey skiff. Maglog was used to record the angular encoder information that determined the angle between the GPS antennas and the MTA tow cable. High-precision depth readings from the tow vessel and the sensor platform were recorded, as were the digital magnetic compass readings from compasses on the tow vessel and on the sensor platform. The magnetometer signals were recorded by Maglog at 20 Hz. All output data from the IMU were recorded (positions, velocities, and accelerations, measuring platform pitch, roll, and yaw). All autopilot information (commands and calculated variables) were recorded by the autopilot computer. The pilot navigation computer measured the course-over-ground (water) and provided the output survey image for comparison with the planned survey course. Both this information and the water depth were displayed in real time to the vessel driver.

All data preprocessing and cleanup were carried out using the Oasis montaj© suite of programs. Filtering was applied (as with all other MTADS data) to remove long term sensor

drifts, to null the zero levels of the magnetometers against each other, to remove (as appropriate) geological interferences, and to smooth electronic interferences. The only identified electronic noise is that from the actuator command signal cables. These occur at 15 Hz and are typically measured to be 0.1-2 nT in the extreme port and starboard magnetometer data. These noise sources are apparent only on the two outboard sensors, which lie closest to the actuator cables.

Fully-corrected mapped data files are the output of the Oasis montaj processing steps described above. The default target analysis GUI was the MTADS DAS that has been specially adapted for both the magnetometer and EMI data. The MTADS DAS is compatible with the Oasis mapped data files described above.

There was no Prove-Out-Site prepared in association with this demonstration. The entire demonstration took place within the bounds of an ordnance Live Impact Area. Other than the carefully installed moorings and the installation of the Calibration Lane targets (all carried out under supervision of NAVFAC by NAVFAC contractors) no activities took place that involved contact with the bottom of the bay. Our operations were strictly non-intrusive

5.4.3 The Calibration Lane: The installation of the Calibration Lane targets was described above in Section 5.2. The Calibration Line targets were surveyed numerous times during the course of this demonstration. We discuss below the results of these activities.

The Calibration Line was surveyed by the MTA five different times on different days. Because the line was installed along a Northwest-Southeast direction each survey pass was carried out quartering into (or with) the wave directions, which were generally from south to north. The line of targets was also installed with the southeastern end near a shoal (above a shallow coral reef). This required a sharp turn with the vessel either onto or from the end of the survey line. Normally three passes (during a single survey of the line) would have been sufficient to cover all the targets. Depending upon the wind and waves, sometimes more passes were required to cover the line. We analyzed the results both from the individual day's surveys

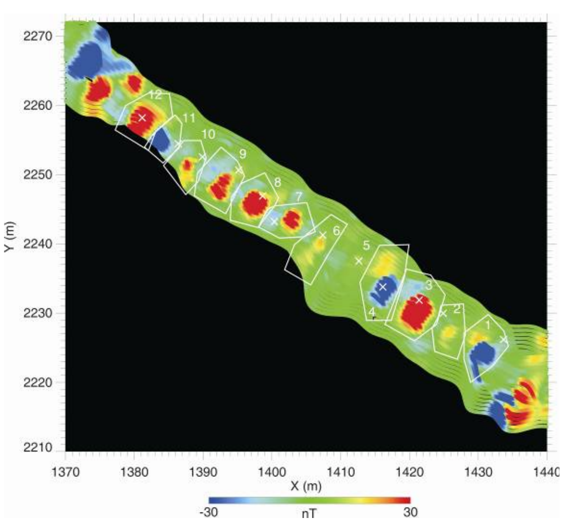

Figure 5-7. This magnetic anomaly image is the 19 June survey of the calibration line. There were six survey passes made.

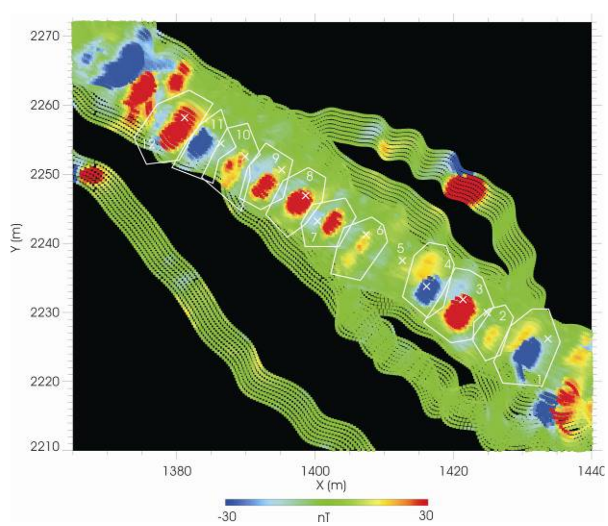

Figure 5-8. This magnetic anomaly image is contains all the data from 5 separate surveys of the Calibration Line.

and from a sum of all the survey passes over the targets from all five surveys. Figures 5-7 and 5-8 show the anomaly image from survey 1 (on 19 June) and the anomaly image from the sum of all the surveys.

The × marks are the reported positions of the calibration targets made by the NAVFAC contractors at the time that they were installed, Table 5-2. It is our belief that the reported positions of the targets have a much larger position uncertainty than positions derived from fitting of the targets from our surveys. The measured magnetic signature of each of the targets is dominated by remnant moment signal. The remnant moment of Target 5 effectively cancels the induced moment, making it undetectable. For the same reason, the signatures of Targets 2 and 6 appear only very weakly. Table 5-3 provides our analyses of the target fitting process for each of the independent survey measurements and for the composite of all the survey passes. The column labeled **(|Δ| From All)** compares the positions derived from each of the individual Calibration Line surveys with the fit positions from the analysis of the sum of all the survey data.

The information in the table shows the variability in the fit positions, apparent signal intensities and the fit qualities. Our ability to accurately and consistently fit the targets was hampered by (1) the remnant moment signals of the targets, (2) the rolling motions of the survey vessel, and (3) most importantly, the imprecise position corrections resulting from the fact that the vessel was turning onto the lane at the beginning or end of each survey pass. The rolling motion of the vessel tended to smear the target signals in the cross track position. In cases where the measured signal intensities were low because the remnant moment opposed the induced moment, the cross-track mispositioning sometimes led the target fitting routine to perceive that there were multiple separate signals and to fit only the stronger signal. The measured signal intensities for individual targets were, in general, consistent from survey to survey and the predicted target sizes were also consistent. The predicted target depths were effectively meaningless, because the signals were dominated by remnant moment, rather than the underlying induced moments.

5.5 Data Collection

Table 5-1 provides the daily operations log for the entire demonstration period. Table 5-4 is a record of the MTA survey operations in the Bahia based upon the information in the electronic files that recorded the magnetometer survey data from the submerged platform. During the survey an additional operations record was composed by the data technician on the survey vessel. This document is referred to at the “Sailing Log.” The information in Table 5-4 was established by the data analysis technician during the data preprocessing step. The Notes from the Sailing Log indicating the survey lines completed and events such as a broken weak link are combined with the time length of the survey file and the derived track length of the survey segment taken in the individual file to create the information in the six columns of the table.

Table 5-3. Target Fitting Parameters for the Five Calibration Line Surveys

Targ ID	Survey	UTM X (m)	UTM Y (m)	|Δ| From All (m)	Min Sig (nT)	Max Sig (nT)	Size (m)	Burial Depth (m)	Moment (amp*m^2)	Fit Quality
Target 1	1	256430.59	2006224.76	0.78	-105.4	19.1	0.198	0.05	3.10	0.92
	2	256430.73	2006225.67	1.65	-92.8	19.1	0.181	0.44	2.36	0.37
	3	256430.45	2006224.59	0.56	-94.1	16.8	0.246	0.68	5.95	0.68
	4	256430.03	2006224.38	0.27	-96.9	17.4	0.256	0.54	6.68	0.78
	5	256430.18	2006223.94	0.20	-110.7	19.6	0.211	0.25	3.76	0.79
	All	256430.13	2006224.13		-110.7	19.6	0.227	0.46	4.68	0.64
Target 2	1	256425.01	2006227.64	0.63	-6.1	17.4	0.109	-0.02	0.52	0.73
	2	256425.74	2006227.33	1.12	-5.8	16.6	0.147	0.98	1.28	0.61
	3	256424.86	2006227.15	0.23	-8.1	16.6	0.114	0.22	0.59	0.89
	4	256424.07	2006226.82	0.65	-5.3	16.6	0.180	0.82	2.33	0.63
	5									
	All	256424.64	2006227.14		-8.9	18.8	0.127	0.50	0.81	0.65
Target 3	1	256420.87	2006230.34	0.56	-22.4	120.2	0.258	0.86	6.86	0.75
	2	256420.55	2006229.85	0.07	-16.5	110.1	0.255	0.55	6.61	0.92
	3	256420.54	2006230.25	0.34	-16.2	125.5	0.233	0.51	5.04	0.89
	4	256420.16	2006229.81	0.36	-16.8	135.2	0.258	0.73	6.91	0.72
	5	256421.67	2006231.48	1.95	-14.8	78.0	0.200	0.81	3.20	0.45
	All	256420.51	2006229.91		-22.4	135.2	0.247	0.70	6.02	0.77
Target 4	1	256416.44	2006234.79	0.43	-67.5	17.3	0.199	0.28	3.13	0.69
	2	256416.23	2006234.06	0.35	-55.3	18.5	0.219	0.78	4.21	0.76
	3	256416.29	2006234.12	0.28	-61.0	19.7	0.180	0.24	2.34	0.74
	4	256415.83	2006234.20	0.46	-60.3	19.0	0.304	1.53	11.29	0.86
	5	256416.70	2006234.54	0.47	-56.1	17.4	0.222	0.84	4.40	0.80
	All	256416.25	2006234.40		-67.5	19.7	0.204	0.82	3.38	0.67
Target 6	1	256406.84	2006240.11	0.88	-9.1	19.3	0.095	0.09	0.34	0.51
	2	256406.24	2006239.80	0.64	-10.6	21.7	0.149	1.10	1.32	0.47
	3	256407.09	2006239.31	1.53	-9.3	18.5	0.101	-0.24	0.41	0.63
	4	256406.98	2006239.34	1.43	-8.8	18.1	0.099	-0.33	0.39	0.68
	5	256406.63	2006239.69	0.94	-6.6	18.0	0.088	-0.28	0.27	0.67
	All	256406.01	2006240.39		-10.7	22.4	0.122	0.45	0.72	0.43
Target 7	1	256401.95	2006243.97	0.91	-17.9	39.1	0.146	0.04	1.25	0.59
	2	256401.52	2006243.62	0.39	-16.7	32.4	0.141	-0.15	1.12	0.86
	3	256401.34	2006243.14	0.13	-17.1	39.5	0.145	-0.02	1.22	0.75
	4	256401.72	2006242.92	0.46	-13.5	39.1	0.158	0.34	1.58	0.78
	5	256401.87	2006243.05	0.51	-9.4	35.6	0.114	-0.05	0.59	0.38
	All	256401.40	2006243.25		-17.9	39.5	0.135	-0.05	0.98	0.44
Target 8	1	256397.39	2006246.17	0.07	-16.8	106.3	0.205	0.19	3.47	0.90
	2	256397.71	2006246.39	0.38	-12.7	83.8	0.215	0.44	3.95	0.81
	3	256397.76	2006245.9	0.39	-12.6	95.1	0.207	0.30	3.52	0.93
	4	256397.16	2006246.04	0.29	-7.6	90.2	0.183	-0.03	2.46	0.86
	5	256397.42	2006246.13	0.02	-9.5	104.2	0.199	0.24	3.14	0.84
	All	256397.44	2006246.12		-16.8	106.3	0.207	0.29	3.52	0.84
Target 9	1	256391.57	2006249.03	0.75	-18.7	46.6	0.204	0.92	3.40	0.52
	2	256392.24	2006249.39	0.14	-15.5	38.8	0.162	0.25	1.71	0.83
	3	256392.31	2006249.86	0.39	-17.6	45.8	0.172	0.55	2.04	0.55
	4	256392.23	2006249.28	0.23	-14.9	35.4	0.173	0.35	2.07	0.53
	5	256393.09	2006248.76	1.19	-15.0	51.1	0.160	0.23	1.65	0.77
	All	256379.25	2006256.59		-18.7	51.1	0.179	0.68	2.29	0.51
Target 10	1	256387.84	2006251.57	1.15	-12.3	30.0	0.130	0.21	0.88	0.81
	2	256388.00	2006251.00	1.10	-10.0	28.6	0.151	0.45	1.39	0.74
	3	256387.34	2006251.38	0.65	-11.3	23.9	0.141	0.62	1.13	0.58
	4	256389.87	2006250.60	2.97	-9.8	25.8	0.200	0.95	3.19	0.49
	5	256388.30	2006251.91	1.72	-8.5	20.8	0.133	0.49	0.94	0.76
	All	256386.91	2006250.89		-17.1	30.0	0.176	1.07	2.17	0.55
Target 11	1	256384.42	2006255.97	2.31	-73.6	9.9	0.160	0.37	1.65	0.54
	2	256382.41	2006254.43	1.41	-61.0	8.8	0.109	-0.03	0.52	0.24
	3	256382.65	2006254.26	1.64	-56.3	9.5	0.173	0.08	2.07	0.94
	4	256383.41	2006255.19	1.44	-52.1	10.7	0.126	-0.13	0.80	0.46
	5	256383.74	2006254.95	1.83	-55.0	11.4	0.175	0.33	2.16	0.70
	All	256382.12	2006255.81		-73.6	18.5	0.243	0.44	5.76	0.51
Target 12	1	256380.93	2006258.11	2.27	-29.1	60.3	0.172	0.52	2.05	0.38
	2	256381.29	2006255.29	2.42	-28.8	58.6	0.331	1.95	14.50	0.56
	3	256379.47	2006256.1	0.54	-14.6	54.6	0.181	0.59	2.37	0.72
	4	256379.29	2006256.22	0.37	-15.1	57.6	0.201	0.38	3.26	0.73
	5	256379.59	2006256.28	0.46	-21.2	50.8	0.341	2.22	15.87	0.56
	All	256379.25	2006256.59		-25.5	60.3	0.285	1.98	9.26	0.50

Table 5-4. Survey Log for the MTA Submerged Platform Survey

Date	Filename	Survey Description	Time (hr)	Distance (km)	Comments
9-Jun	BSDS1	NS Tracks 76-78 & 50-51	1.33	6.55	
	BSDS2	79-81 & 52-55	2.23	11.60	
10-Jun	BSDS3	82-83 & 56-57	1.20	6.51	
	BSDS4	58			Weak link broken
	BSDS5	84-85 & 58-60	2.12	8.12	2 more weak links broken on 58
	BSDS6	86-87 & 61-62	1.37	6.55	
	BSDS7	88-89 & 63	1.00	4.41	
	BSDS8	64	0.32	1.82	
	BSDS Registration	90			Back & forth over the same track for calibrating sensor positions
11-Jun	BSDS9	91-92 & 65-66	1.44	5.87	Weak link broken on 65
	BSDS10	93-95 & 67-68	1.28	6.03	
	BSDS11	96-98 & 69-71	1.56	7.04	Off course – S half of 98
	BSDS12	99-100 & 72-73	1.00	4.03	Off course on 100
	BSDS14	100 & 74-75	0.82	3.43	
	BSDS15	101-103 & 123-124	1.30	4.99	
	BSDS16	104-105 & 126-127	1.20	5.24	Showers while on 105
	BSDS17	106-108 & 128-129	1.36	5.09	
	BSDS18	109-110 & 130-132	0.93	3.74	2 mags quit while on 132
19-Jun	BSDSCAL	Tracks over Calibration Line			
	BSDS20	111-113 & 133-135	1.55	6.65	Avoid mooring on track 111
23-Jun	BSDS21	114-115 & 136-137	1.00	4.21	
	BSDS22	116-117 & 138-139	0.92	4.01	
	BSDS23	118-119 & 140-141	0.98	4.06	
	BSDSCAL2	Tracks over Calibration Line			
	BSDS24	120-121 & 142-143	0.98	4.18	
	BSDS25	122-123 & 144-145	1.31	5.18	Weak link broken on 144
	BSDS26	34-35 & 48-50	1.23	5.31	
	BSDS27	33 & 47	0.52	2.19	
24-Jun	BSDSCAL3	Tracks over Calibration Line			
	BSDS29	30-32 & 44-47	1.71	7.11	
	BSDS30	27-29 & 42-43	1.21	5.19	

This information was used to assemble the survey production statistics for the MTA survey, see Table 5-5. Based upon the preprocessed MTA survey files, slightly less than 160 line km were surveyed. This corresponds to a blanket survey coverage area of just under 200 acres (not counting the surveys of the Calibration Lane). The overall survey production rate was about 5.3 acres per hour. This survey production rate is equivalent to all the other MTA surveys in areas where reasonably long survey lines could be set up.

Equivalent production statistics information for the Skiff survey is provided in Table 5-6. The Survey Log for the skiff survey is shown in Table 5-7. The survey grid for the skiff survey was set up with 4 meter wide lanes. This left the option for driving an extra pass half way between the survey grid lines to provide overlapping coverage. For the most part the survey was conducted only on the 4 meter spacing. Although this may have allowed some very small items to pass undetected between the survey lines, larger items were clearly detectable and could be fit

Table 5-5. MTA Survey Statistics Based Upon Data Files

Survey Length		157 Line km
Survey Duration		36.33 hr
Survey Area		785,250 m^2
		78.5 Hectares
		194 Acres
Production Rate		2.16 Ha/hr
		5.34 ac/hr

Table 5-6. Skiff Survey Statistics Based Upon Data Files

Survey Length	80.3 Line km
Survey Duration	12.1 hr
Survey Area	321,080 m^2
	32.1 Hectares
	79.3 Acres
Production Rate	2.7 Hectares/hr
	6.6 acres/hr

Table 5-7. Survey Log for the Skiff Survey

Filename	Survey Description	Time (hr)	Distance (km)	Comments
BSDS east sm1	NS Tracks 1-18	1.214	9.01	Turned on Inverter on 12
BSDS east sm2	19-34	0.936	7.15	Reset NAV Computer on 25
				Turned off Inverter on 29
BSDS east sm3	35-64	1.162	7.52	Turned on Inverter on 45
				Reset NAV Computer on 62
BSDS west sm1	NS Tracks 1-14	0.762	3.96	
BSDS west sm2		1.073	5.85	
BSDS west sm3		1.162	8.45	
BSDS west sm4		1.114	8.75	
BSDS west sm5		0.935	7.24	
BSDS main sml2		0.992	6.62	
BSDS main sml3		0.59	3.81	
BSDS main sml4		0.707	4.25	
BSDS main sml5		0.554	2.9	
BSDS main sml6		0.893	4.76	

in target analyses yielding good fit parameters. The skiff survey area was broken up into 3 blocks along the north side of the bay (east, central, and west). The nomenclature in the survey files (for instance in Table 5-7) ‘BSDS east sm1’ denotes the east block skiff survey in the Bahia Salinas del Sur with a file name of “skiff mission 1.”

In general, the skiff survey speed was slightly faster than the MTA survey speed. The skiff speeds were limited by the wave conditions. On the eastern and part of the central survey blocks, the waves were low because the area was protected by the reef and shoals on the eastern side of the bay. When the skiff was surveying with a following sea, the survey speed could be increased so that the boat effectively surfed in the trough between the waves. Surveying in the opposite direction, the skiff had to plow into the waves. This caused a pitching motion, which raised and lowered the magnetometer positions, sometimes by more than a half a meter. The change in the Earth’s field over this distance introduced a periodic noise in the survey signals

that was equivalent to the signals from smaller ordnance objects. This periodic motion was at a frequency (similar to the footprint of small ordnance) that did not allow it to be filtered out. In general, the skiff survey data is slightly inferior to the MTA data (because of the data density and the pitching noise).

A magnetic anomaly image of the entire skiff survey is shown in Figure 5-8 over an orthophoto of a part of the LIA and the Bahia. The yellow lines show the approximate boundaries of the NOAA bathymetry survey One of the Calibration Line surveys is also shown (crossing the northeast corner of the NOAA survey boundaries. Sea grass (dark gray to black) and coral (light gray to tan) is visible in parts of the orthophoto image. Former impact targets are visible on land as bare surface scars in the terrain. The white sand beaches are very nice and often attract tourist vessels (traveling between the outer tourist islands and the large island of Puerto Rico). These boats often anchor in the Bahia, in spite of the ordnance danger warning signs on the beaches.

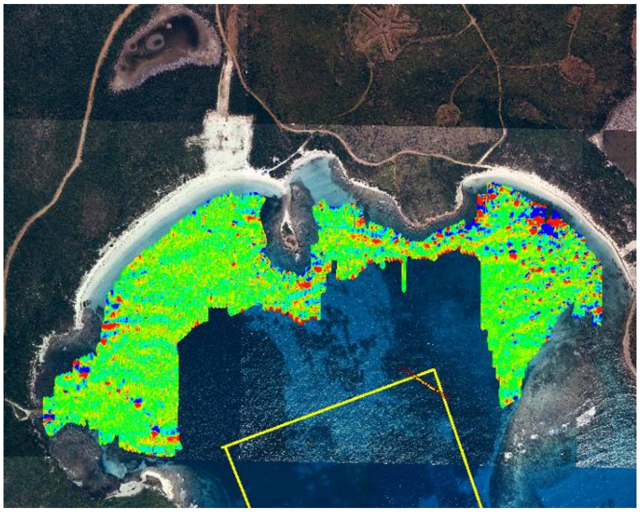

Figure 5-8. Magnetic anomaly image from the skiff survey along the north shore of the Bahia. The presentation scale is ±30 nT.

The intense magnetic returns along the northeastern shoreline and along the western shoreline result from visible debris associated with a former pier and other large metallic structures (possible former shoreline targets). Many of the impact areas visible on land are obviously tanks and other military vehicles that were placed there as targets.

Figure 5-9 shows a magnetic anomaly image of a portion of the skiff survey from near the eastern edge of the Bahia. The 4 meter wide survey lines do not provide complete coverage, however most targets can be effective analyzed from this data. The boxed targets in the image were from a first analysis pass of the data; this pass was not intended to be an exhaustive analysis. The actual results of the target analyses are discussed below.

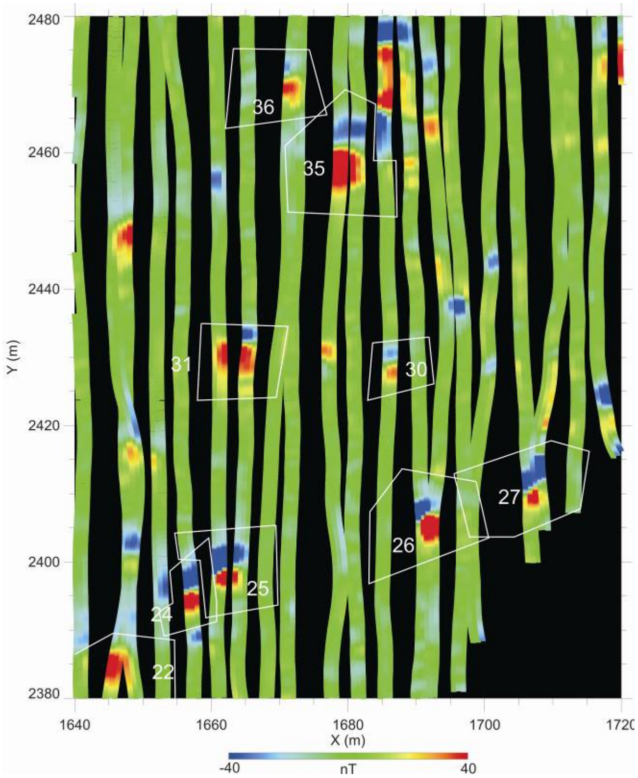

Figure 5-9. This is a survey clip of about a 2 acre area of the skiff survey just north of the shoals on the east side of the Bahia.

The line keeping ability in the skiff surveys was slightly more difficult than with the MTA tow vessel because the wind and the waves tended to push the relatively small skiff around more than they did the 40 ft long MTA tow vessel.

Figure 5-10 shows a survey overview containing both the skiff and the MTA surveys. It is superimposed on the same composite orthophoto shown in Figure 1-2. The presentation scale is ±30 nT for each survey. The two surveys mate up to provide nearly continuous coverage of the central and northern parts of the Bahia. The most obvious features of the top level survey are the three clumps of massive magnetic anomalies immediately north of the tiny island, Roca Alcatraz, see Figure 1-2. All the anomalies in these large clumps (and likely others nearby) are associated with the former target ship Killen. The most recent diving surveys of these areas conclusively showed[14] that the Killen broke up into three major sections, which give rise to the anomalies in the image. Many of the larger ship components have become artificial reefs, hosting both coral buildups and schools of different types of tropical fish.

There are relatively large numbers of small, medium, and large magnetic anomalies scattered widely across the Bahia. In general, the density of these anomalies falls off as one moves south of the two islands that guard the mouth of the Bahia. The density of anomalies that are likely ordnance related are lower on the western side of the Bahia. The large magnetic returns along the western shoreline are likely associated with a former pier and other structures. The majority of the larger anomalies that are visible at this scale along the shoreline are much too large to be associated with individual ordnance items.

Figure 5-11 shows a 2.5 acre clip of the analyzed data from the MTA survey. This area is about 100 m east of the main Killen wreckage. It is likely that most of the anomalies in the image are not directly associated with components of the Killen. The complete results of the analysis of the anomalies in the MTA survey are provided in Appendix C. A total of 532 targets were analyzed. Anomalies that were clearly associated with (or with signals overlapping with) the major components of the Killen wreckage were not analyzed.

Table 5-8 shows an excerpt from this list, which contains only the 22 anomalies shown in Figure 5-11. These anomalies are typical of those appearing in the remainder of the MTA survey. Each of these analyzed anomalies is consistent with ordnance signatures. The two largest targets (228 and 231) may contain signals from multiple objects. The targets with the greatest predicted burial depths (231 and 233) may be incorrectly fit because they are multiple targets or (in the case of target 231) have anomaly signals dominated by remnant moment.

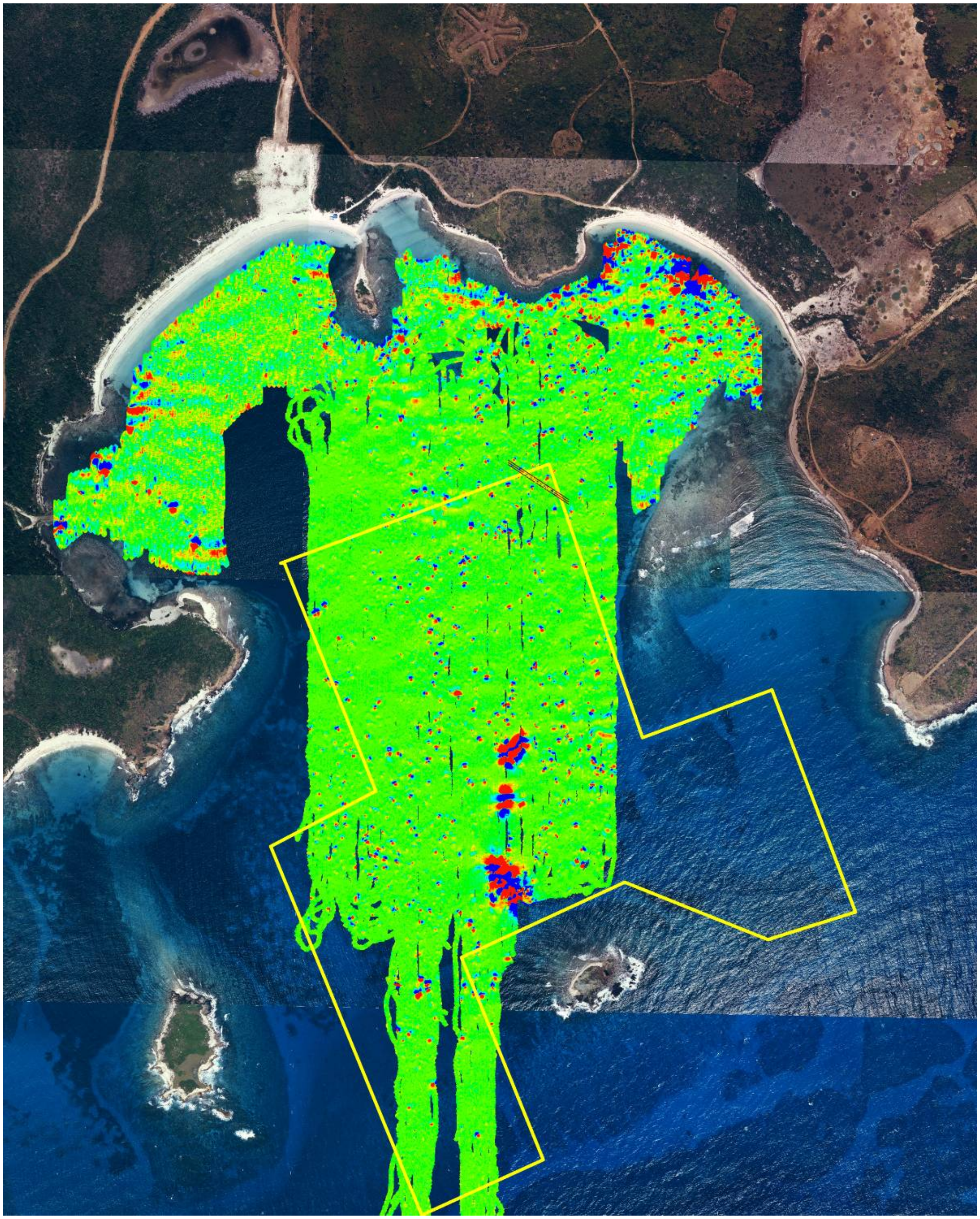

Figure 5-10. This is a magnetic anomaly image of both the skiff and MTA surveys overlaid on an orthophotograph.

The target list from the analysis of the Skiff survey data is also provided in Appendix C. The analysis of this data resulted in fitting of 71 ordnance targets. The nine anomalies shown in Figure 5-9 have analysis results presented in Table 5-9. The water depth throughout the 20 survey passes partially shown in Figure 5-9 is consistently near 2 meters. The predicted target sizes are similar to those shown in Table 5-8 from the MTA survey. It was the analyst's conclusion, based upon the predicted burial depths and the fine structure in the anomaly signatures that 6 of the 9 targets were possibly or likely the result of geological returns. The rocky outcroppings near the shoreline were clearly the source of geological returns, particularly in the skiff survey. The deeper water in the main part of the Bahia had a more significant layer of homogeneous sand on the bottom, and thus much less geological interference.

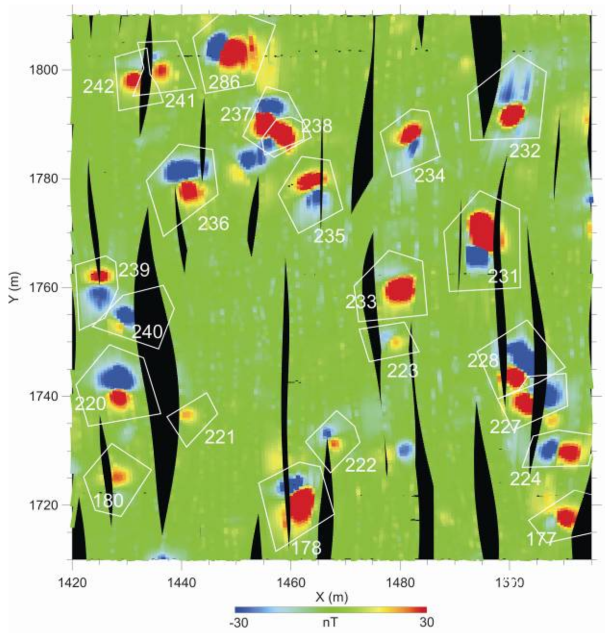

Figure 5-12. This is a survey clip of about 2 acres of the MTA survey. This area is east of the center clump of the Killen wreckage, near the eastern edge of the survey.

5.6 Validation

At the time this report was composed there had been no attempt to retrieve targets from the Bahia. There have been numerous explorations of the Bahia, particularly by divers investigating the Killen wreck and divers investigating the environmental conditions in the Bahia. Many photographs of intact ordnance lying on or proud of the bottom have been published in these reports. We made no attempt to correlate these images with our survey results and we carried out no dive activities on our own in association with the survey. The target lists and analysis results in the target tables in Appendix C could easily form the basis for investigation of individual targets, which could be reacquired from the data in this report. There have not been any major storms since our survey that would likely have disturbed the targets that we analyzed. Many of the targets (visible in the photographs) are partially buried or are partially overgrown by coral and would be expected to move only in the most violent storms.

Table 5-8. This Table Shows the Analysis Results for the Anomalies Shown in Figure 5-2

Survey Measured Values								Fit Values				
Targ ID	Local X (m)	Local Y (m)	UTM X (m)	UTM Y (m)	Water Depth (m)	Min Signal (nT)	Max Signal (nT)	Burial Depth (m)	Size (m)	Moment (amp m^2)	Fit Qual.	Analyst Comments
177	1509.33	1717.91	256509.33	2005717.91	8.87	-14	47	0.55	0.233	5.075	0.878	large target, mildly inverted
178	1460.99	1722.15	256460.99	2005722.15	8.96	-79	107	0.54	0.359	18.460	0.870	very large target, good prospect
180	1427.82	1724.57	256427.82	2005724.57	8.95	-12	25	1.07	0.268	7.680	0.932	large deep target
220	1428.67	1742.30	256428.67	2005742.30	8.99	-81	44	0.69	0.370	20.242	0.803	very large target, good prospect
221	1441.15	1737.27	256441.15	2005737.27	8.95	-4	22	-0.09	0.133	0.937	0.667	medium small target on surface
222	1467.19	1732.58	256467.19	2005732.58	8.78	-32	26	0.03	0.194	2.915	0.911	large target on surface
223	1477.93	1750.65	256477.93	2005750.65	8.58	-19	20	-0.18	0.174	2.122	0.589	large target, on surface
224	1508.90	1730.65	256508.90	2005730.65	9.11	-43	43	0.64	0.333	14.835	0.946	very large inverted target
227	1504.57	1740.45	256504.57	2005740.45	9.27	-70	70	-0.06	0.366	19.620	0.901	very large target, on surface
228	1502.13	1745.49	256502.12	2005745.49	9.20	-156	82	0.47	0.410	27.598	0.933	Huge very inverted shallow target
231	1494.39	1770.29	256494.39	2005770.29	8.88	-71	152	1.67	0.499	49.621	0.667	Detrend shows two overlapping targets
232	1499.93	1792.39	256499.92	2005792.39	8.54	-26	130	0.92	0.357	18.148	0.841	Very large target, good prospect
233	1479.06	1761.25	256479.06	2005761.25	8.30	-11	73	3.35	0.358	18.426	0.677	large target, poor fit and depth because of overlapping signals
234	1481.97	1787.48	256481.97	2005787.48	8.44	-22	68	0.44	0.259	6.947	0.815	large shallow target
235	1463.79	1778.67	256463.79	2005778.67	8.98	-35	67	0.12	0.293	10.018	0.934	large inverted target on the surface
236	1440.47	1780.57	256440.47	2005780.57	8.53	-93	41	0.73	0.363	19.135	0.949	very large target, with large remnant component
237	1455.77	1792.19	256455.77	2005792.19	8.86	-53	68	0.26	0.307	11.564	0.667	large shallow target, 2nd target 2 m SE
238	1456.89	1788.08	256456.89	2005788.08	8.94	-35	98	-0.10	0.293	10.107	0.931	large surface target, 2nd target 2m NW
239	1424.58	1760.94	256424.58	2005760.94	8.56	-34	36	0.87	0.301	10.885	0.949	large target, with large remnant component
240	1430.47	1754.49	256430.47	2005754.49	8.88	-53	20	2.39	0.336	15.139	0.604	target is all remnant
241	1435.35	1801.93	256435.35	2005801.93	8.63	-21	30	0.49	0.214	3.905	0.616	medium sized target
242	1430.89	1798.81	256430.89	2005798.81	8.79	-14	41	0.18	0.193	2.855	0.684	medium sized shallow target
286	1448.06	1804.54	256448.06	2005804.54	8.50	-102	79	0.07	0.339	15.605	0.799	very large target

Table 5-9. This Table Shows the Analysis Results for the Anomalies Shown in Figure 5-9

Survey Measured Values								Fit Values				
Targ ID	Local X (m)	Local Y (m)	UTM X (m)	UTM Y (m)	Water Depth (m)	Min Signal (nT)	Max Signal (nT)	Burial Depth (m)	Size (m)	Moment (amp m^2)	Fit Qual.	Analyst Comments
S-22	1644.75	2384.90	256644.75	2006384.90	1.83	-9.8	64.2	2.40	0.41	27.299	0.882	likely is geology
S-24	1656.25	2395.74	256656.25	2006395.74	1.82	-60.1	61.7	0.97	0.34	15.630	0.955	large deep target, may be geology
S-25	1661.34	2399.35	256661.34	2006399.35	1.75	-170.6	68.6	0.56	0.36	19.354	0.821	very large target, good prospect
S-26	1691.14	2406.69	256691.14	2006406.69	1.58	-72.9	116.3	0.77	0.32	12.976	0.936	very large target, good prospect
S-27	1707.93	2411.99	256707.93	2006411.99	1.40	-78.8	48.7	1.66	0.33	13.848	0.584	very large target, may be geology
S-30	1686.29	2429.29	256686.29	2006429.29	1.65	-26.6	33.6	0.85	0.23	4.999	0.974	large deep target
S-31	1663.62	2432.77	256663.62	2006432.77	1.82	-45.2	47.2	1.42	0.38	22.168	0.835	likely is geology
S-35	1678.71	2460.29	256678.71	2006460.29	1.88	-39.2	90.2	2.16	0.48	45.318	0.934	geology
S-36	1669.96	2471.39	256669.96	2006471.39	2.05	-24.4	46.1	0.98	0.36	17.890	0.918	very large target, may be geology

6.0 DATA ANALYSIS AND SURVEY WORK PRODUCTS

The primary Work Products of the Demonstration are the analysis and reporting of the MTA survey results from the Calibration Lane, the MTA survey results from the survey of the main body of the Bahia, and skiff survey of the shallow water areas on the northern perimeter of the Bahia. The data processing, target analysis, and preparation of the target lists and results were completed long after the completion of the survey because there were no plans to investigate any of the analyzed targets in the Target List. Survey data were preprocessed each day from that day's survey and were available the following day for survey planning. Data preprocessing was carried out promptly primarily as a Quality Control step that would allow us to avoid continued collection flawed or invalid data.

The remainder of this chapter describes the workflow and processes used to accomplish these tasks. The general results of our survey, including some spot target analyses and overall survey graphics were presented orally to NAVFAC Lant, NAVFAC Antilles, members of the local environmental regulatory agencies, and local citizens group representatives at a briefing at a RAB meeting held on Vieques on Thursday 28 June following completion of all of our survey activities, see Table 5-1.

The target analyses for the entire survey are presented in Appendix C of this report.

6.1 Survey Data Preprocessing

Raw survey data were processed using standard Geosoft montaj® utilities and were available for inspection the next morning following the prior day's survey. The techniques that are used to preprocess the raw data are equivalent to those that we have used for over a decade to prepare data from other marine surveys, from helicopter magnetometer array surveys, and from towed vehicular surveys. Data were censored from turn-arounds and periods when the platform is not moving (*e.g.* repairing broken weak links). The individual sensor baseline levels are correlated and a down-the-track smoothing filter is applied to the data. The data were leveled to a common null point (each time datasets were combined) and finally, the data were interpolated onto a (previously established) grid for loading into the target (anomaly) analysis software. Several other quality control checks are also applied each time a dataset is preprocessed. These include confirming that the appropriate layback values (associated with each cable deployment) are being used, that the angular encoder, platform yaw, and platform altitude values are correct and consistent. These are evaluated primarily by using data image inspections.

"Course-Over-Ground" plots and dipole image presentations of the data were prepared, which allowed additional quality control evaluations to be made. Additional Track Files were prepared (as required) for insertion into the Pilot/Survey Guidance display to allow resurvey of areas that were missed or areas where survey data quality was not acceptable.

Each day the master survey data file was updated to include all accepted survey data. The combined files were formatted for input to the MTADS DAS; separate files were prepared for the MTA calibration line and main Bahia surveys and for the skiff surveys.

6.2 Target Selection and Target Analysis

The target analyses were carried out as three separate processes; one for the various survey files associated with the Calibration Line, the second for the remaining MTA survey files, and the third from the skiff survey files. The calibration line survey analyses are described in Sections 5.2 and 5.4.

The MTADS DAS (version adapted for MTA analyses) was used for all target analyses in this demonstration. The MTADS DAS target fitting routine carries out an iterative fit of the sensor information in a data clip (defined by the analyst to encompass the visible anomaly) to a dipole signature. The input data to the fitting routine are based upon three dimensional coordinates (the UTM coordinates and HAE of each sensor reading) and the value of the sensor reading. This allows overlapping data from multiple passes of the sensor array (at differing heights above the bottom) to be appropriately incorporated. The fitting routine is fully three dimensional and the output of the fitting process reports the coordinate position of the center of the object (UTM coordinates and HAE), the apparent induced magnetic moment and the inclination and azimuth of the induced dipole, the fit quality of the dipole approximation, and a derived predicted caliber of the target (assuming a cylindrical shape with a length to diameter ratio of 4). Additionally, the maximum and minimum signal strength and the water depth at the target position are reported.

Figure 3.4 shows a screen clip from the MTADS DAS analysis of an individual target in the MTA survey. The discussion below describes the analysis workflow and some of the analysis images, tools, and routines available to the analyst for the fitting process. The Site View window (partially shown on the upper left of Figure 3.4) shows the entire survey area with an 80 X 80 m analysis area outlined in white. The analysis window (shown on the lower left) is used by the analyst to select individual targets for analysis. In this case the analyst has boxed an area by using the computer mouse to draw a polygon surrounding the anomaly. The position and display scale of any of the images shown in the figure can be changed by the analyst. The data bounded by the polygon are submitted to the analysis algorithm to carry out the iterative fit described in the previous paragraph. The fit window (half of which is shown on the right of Figure 3-4) shows plots of the data submitted for analysis and the best dipole fit to that data (The fit image lies to the right of the image that is shown in Figure 3-4). The image in the Fit Window shows that this anomaly has data contributed from parts of three passes by the sensor platform. If the analyst notes that there are contributions from an additional anomaly in the Fit Data, using the computer mouse he can delete the parts of individual sensor tracks from the analysis, and then rerun the analysis. Alternatively, if the analyst notes that there are widespread geologic features that contribute a varying interference offset to all the data displayed in the Fit Window, he can invoke a leveling tool that will level all the data in the display to the best flat background level. The fit can then be rerun. Following the iterative fit, which usually takes about one second, the Fit Values are displayed on the left side of the Fit Window. In the center panel of the displayed area of the fit window information is provided about the signal parameters, the (raw) estimated depth, and the water depth. The estimated burial depth must be later corrected for the (variable) depth of the sonar sensor below the water surface. In this case, it was 0.5 m, so the predicted burial depth is only about 0.3 m. On the lower right of the Fit Window display are radio buttons for several analysis options available to the analyst. These are described below.

The analyst has several additional tools to help him make decisions about an individual target and the fitting process that has taken place. These tools include: (1) a 3-dimensional presentation of the altitude above the bottom for each sensor track for the various platform passes that contributed to the analysis data; (2) a 3-dimensional presentation of the individual sensor readings along the tracks created by the platform passes contributing to the analysis data; and (3) a 3-dimensional plot of the residuals resulting from subtracting the dipole fit from the data entered into the analysis. The altitude plot can be used to quickly determine the altitude above the bottom of the sensor platform in the passes that contributed to the data clip and to show whether the platform was in a roll attitude during one of the passes. The plot of the sensor data can reveal many things such as whether there were multiple objects contributing to the signal, whether there was clutter around (or on top of) the primary object that confused the dipole fit, or whether there were significant remnant moment contributions to the signature. Once the analyst is satisfied with the overall fit process, he has the option to type in a narrative comment and accept the fit as part of the record.

Following the initial fitting process, additional recorded sensor data from the vessel and the sensor platform are used to reduce the HAE value of the target fit to a burial depth of the object below the sediment surface. Before each target fit is logged, the analyst has the opportunity to record narrative observations relating to the target and a subjective target classification approximation. In this demonstration, targets were not classified as to their probability of being ordnance. Because there was no Prove-Out-Site with known ordnance targets, and there were no targets recovered, there was no basis for establishing an ordnance probability scale.

6.3 Parameter Estimates

Based upon the list of ordnance recovered from the UXO clearance operations that have taken place on land in the LIA, we expected to encounter the full range of ordnance sizes from 20 mm projectiles (and sub-munitions) to 1,000 lb bombs, see Table 4-1. The individual examples of all the smaller cartridges, grenades, fuzes, etc are below the detection limit for the MTA (with or without) geological interference effects considered. Therefore, there are basically no threshold size limits that can be applied to filter targets from the list of potential ordnance items. We have extensively discussed in Section 6.2 the various parameters, displays, and analysis and fitting options available to the data analyst for target fitting. Any attempt to differentiate between ordnance and non-ordnance cannot be based exclusively upon size analysis. We have noted in our analysis comments where the anomaly characteristics were inconsistent with ordnance signatures or where anomaly signatures appeared to be typical of geological returns.

6.4 Classifier and Training

Classification of anomalies by probability of their being ordnance and by likely identity (size) was not done in the target analysis process for reasons described above.

As extensively described above, a single human analyst working with the MTADS DAS software utility analyzed all data using the parameters generated from the MTADS DAS anomaly fits, the additional available MTADS DAS analysis tools described above, and subjective impressions based on decades of experience.

6.5 Survey Work Products

In the Bahia Salinas del Sur magnetometry survey, many strong anomaly signatures were not analyzed (or at least were not recorded as part of the Target Report). These included massively big objects that could not possibly be individual ordnance items, extended objects (likely pipes, cables, anchor chains, etc), and areas adjacent to the shoreline that visually were identified as manmade structures that had been destroyed by ordnance.

Additionally, we excluded from analysis the strip of the Bahia that was clearly associated with major components of the wreck of the Killen. These were dominated by the three major components of the hull and the drive components, but also contained many other smaller components of the wreckage. Through the ten (or so) survey grid lanes that passed over the main part of the wreckage, the platform altitude was raised to between 2 and 3 meters to avoid collision with the hull components. The Target Report for the MTA survey contained 526 entries; the corresponding Target Report for the skiff survey contained 71 entries. The target reports are included in Appendix C. Because there was no indication that the Navy planned to investigate or recover targets, we made no attempt to sort the target lists into prioritized lists that we would recommend for intrusive analysis.

7.0 Performance Assessment

The quantitative and qualitative performance objectives are enumerated in Tables 3-1 and 3-2. In Table 3-1 a specific descriptive response has been entered describing the performance evaluation for each of the quantitative objectives. These address quantifiable performance measurement issues such as production rates, survey coverage, data processing, and detection and location accuracies**.** Because no intrusive activities, target identifications, or recoveries took place, and because there was no POS, issues relating to accuracies of target positions and depths are moot.

As explained in Section 3, station keeping, line keeping, and survey missed areas were primarily a function of the driving skills of the Charter boat captains. Several different captains were used and their skills (and the ability to learn skills) varied considerably among them. Survey coverage overall was very good (considering the weather and surface conditions). In some instances coverage was improved by using our own staff to pilot the charter vessel. In addition, we devoted considerable effort to resurvey of some of the grid lines involving significant missed areas.

The issues involving the calibration targets, the survey of the calibration line, and the location accuracies of the calibration targets was addressed in Section 5.2 and Section 5.4.3.

Survey production rates for both the MTA platform and the Skiff surveys are discussed in Section 5.5 and summarized in Tables 5-4, 5-5, 5-6, and 5-7. In general, the actual survey rates (acres per hour or acres per day) vary very little for either the MTA platform or the skiff survey platform from demonstration to demonstration. Our typical survey rates are 5-6 acres/hour for the MTA platform and 6-7 acres/hour for the skiff platform based upon actual survey times.

A much more important factor is our ability to efficiently commute to and from the survey site and losses due to weather, high sea states blocking our commute, and the unreliability (in some situations) of the charter captains. Overall, we surveyed nearly 275 acres of the Bahia with the MTA and skiff platforms during the 7 partial days that the MTA platform surveyed and the 4 partial days that the skiff surveyed, see Table 5-1.

The qualitative objectives are addressed in Table 3-2. Those objectives addressing logistics, on site support issues, and accessibility are addressed in detail in Section 3 and in several subsections of Section 5.

The operational performance of the MTA equipment and the data collection and processing were in general, excellent. Major equipment breakdowns were limited to the EM system which failed to operate, as explained in Section 3, and to the loss of the TV visualization and recording system. The poor performance of the EM system is primarily the result of poor system design (both mechanical and electronic). The loss of the TV system was the result of in ability to access the platform because we were ejected from the Bahia while an ordnance demo took place on the LIA. It was explained in Section 3 that the TV camera loss was due to mooring failures during a squall. Other minor equipment malfunctions were either addressed *in situ*, or the components were replaced from inventory spares.

The weather and the sea state conditions were a significantly greater challenge to the MTA system than we have encountered in any of our previous demonstration surveys. We managed to conduct MTA platform surveys with trade winds of up to 20 kts and in seas between 2 and 3 feet. Operations in these conditions would not have been possible using our pontoon boat as a tow vessel. The larger charter vessel was much more seaworthy.

A second operational issue involving winds and sea state is the pitching motion of the tow vessel created primarily by the waves. When the vessel suddenly pitches forward over a wave, very large G-forces are transmitted into the tow cable because the mass of the platform and the trapped seawater is more than 3,000 lbs. This typically results in the separation of the weak link, which is installed between the tow arm and the tow cable. This link is designed to break at about 1,200 lbs to protect the tow cable and the tow platform from damage. Before we began the demonstration survey on Lake Erie,[13] we procured and installed a flexible cable (manufactured by Seaflex AB (Sweden)) between the weak link and the connection to the tow cable. See Figure 7-1. This cable stretches under tension. The particular cable shown in the figure is designed to stretch from 3 to 5 ft in length before sufficient tension is created to break the weak link. The use of the flex cable significantly reduces the G-forces resulting from pitching of the tow vessel. We still broke many weak links during this survey, but it would have been impossible to have conducted surveys under these conditions without the flex cable.

Figure 7-1. This image shows the weak link (mounted between the shackles at the end of the tow arm) and the Seaflex cable (the dark cable between the weak link and the tow cable).

8.0 Cost Assessment

The instructions for this section direct that cost information should be supplied so that a professional involved in the field could reasonably estimate costs for implementation of this technology. Many of the costs associated with this demonstration were unique to this particular demonstration and would not be expected to necessarily apply to use of the MTA at other domestic sites. The costs for this operation that were unique and were not typical or other demonstrations of the MTA include:

- Shipping requirements involved both trailer truck and open ocean barge transport, vehicle rentals (effectively) in a foreign country, and secondary transportation for all equipment between islands using commercial ferries.
- Procuring access to suitable charter vessels required that we charter from a resort marina provider for vessels used for resort pleasure diving support.
- Accommodations during the demonstration were in a resort hotel at resort prices (~200% of the government per diem rates).
- Many days of operational time and productivity were lost because of sea conditions that did not allow the charter vessel that was provided for transportation between the dock and the work site to operate. Difficult commutes (morning and night) are not unique for the MTA; however, in this situation the commute involved a 15 mile open ocean trip using a small recreational vessel.
- More than $30K was required to specially charter LCM vessels to lift and transport the MTA equipment between the dock and the worksite, and between the worksite and the ferry dock to complete demobilization.
- Several survey production days were lost to in order to carry out the required modifications to the charter vessel, which the vessel owner could not carry out independently.
- Several days (and several more half days) of work were lost because of breakdowns of the chartered vessels and because the charter pilots either showed up for work late, or did not show up.

Fortunately, the two demonstration surveys that took place immediately prior to this one provide excellent cost models for deployment and operation of this equipment. The first example that we suggest is our demonstration survey at Ostrich Bay on Puget Sound.[8] This demonstration required that we use commercial transportation to move our equipment from Cary, NC to Seattle and an (overwater) mobilization of 20 miles to the work site. The demonstration was a textbook example of a typical blanket coverage magnetometry survey of several hundred acres. We refer the reader to Chapter 8 of Ref 8.

The next demonstration was carried out on Lake Erie.[13] Mobilization and demobilization was inexpensively carried out using rental vehicles towing the boat trailers. We were able to mobilize to and operate from an inexpensive marina that was only about 200 yards from the edge of the survey site. In this demonstration, we carried out an extensive transect survey of very large areas of the Lake. Some parts of the survey were carried out more than 12 miles off shore (requiring long commute times from the dock to the survey grid). Except for some weather complications and some weather delays near the end of the survey, this demonstration was

carried out in a straight forward manner. The cost model for the Lake Erie demonstration provides a second good example for a professional to evaluate the costs to deploy this technology on a typical (domestic) marine range. The reader is referred to Chapter 8 of Reference 13.

8.1 Cost Model

The cost model for the Vieques demonstration is basically the one that we developed and presented as Figure 5-1 in the Vieques Demonstration Test Plan. The table from the Test Plan is reproduced on the following page. Most of the information in Table 8-1 was based upon firm prices and quotations (airfares, equipment transportation, SAIC labor, charter boat costs, etc). Therefore, the cost model was realistic based upon the expected course of the operation. The difference in the cost model and the actual costs were associated with unexpected and unforseen events and conditions that were encountered during the operation. The layout of the information in Table 8-1 is fairly true to the sample cost model template provided in the Report Guidance. The missing information is the section on the Instrument Cost. The instrument was designed and developed in a complex effort involving both SERDP and ESTCP projects. These developments took place in 2002-2004. The costs associated with the original development are not particularly relevant to the costs of manufacturing a new MTA system. The capabilities of the current MTA are significantly different than the original requirements including the ability to operate in open waters and in sea state conditions up to Sea State 2. The operational water depth for routine MTA operations currently is more than a factor of 2 greater than the original design. During the last 6 years. the state-of-the-art in computers, electronics, and data handling/transfer techniques has changed greatly. One would not want to specifically recreate the original MTA system. However, for several marketing exercises, we have estimated the cost of manufacturing a new MTA system with roughly the current capabilities, with new technology components, and with the capability of productively working in water depths of up to 50 feet. These cost estimates vary between \$450K and \$700K depending upon the specific system requirements that are assumed.

In Table 8-2 we provide a summary of our operational costs for the Vieques Demonstration. A one week demonstration of the MTA system took place in Culebra one week after the Vieques survey work was completed. The equipment was returned to Fajardo following the Vieques survey. Costs of moving the equipment from Fajardo to Culebra, conducting the Culebra survey, and demobilizing all equipment back to Fajardo do not appear in Table 8-2.

Table 8-1. Cost Estimate for a 4 Week MTA Survey on Vieques (Adapted from the Vieques Demonstration Test Plan)

	Expense	Airfare	Labor	Comment	Lodging/ Per Diem	Gas	Total
Mobilization							
Evaluation Trip (Logistics)			$7,414.32		$1,089.00		
Round Trip RDU/SJU		$740.00					
Round Trip SJU/VQS		$399.00					
MTA Repair and Upgrade	$15,000.00						
Coral Queen Buildout/3 days							
Sea Ventures	$2,500.00						
SAIC		$740.00	$4,821.60		$1,089.00		
SUV/3 days	$525.00					$40.00	
Materials	$500.00						
Equipment to Vieques							
Load-out/Cary	$250.00						
Transport Cary-San Juan 45ft flatbed, Land Marine Cargo	$5,400.00						
Customs Expediter	$1,000.00						
Off-Load to Box Truck	$250.00						
Box Truck/2 days	$143.93					$50.00	
SUV/2 days	$350.00					$30.00	
Ferry Fajardo/Vieques	$300.00						
3 Boats Fajardo/Vieques	$2,800.00				$363.00		
SAIC Support							
Round Trip RDU/SJU		$2,960.00					
Round Trip SJU/VQS		$1,596.00					
All hands one day (4 men-8 hr)			$12,017.76		$726.00		
Subtotal	$29,018.93	$6,435.00	$24,253.68		$3,267.00	$120.00	
TOTAL MOB COSTS (Includes marina and charter boat/crews)							**$63,094.61**
Survey Operations							
SAIC Costs							
Week 1, 5 days*12hr+ 2 days*8hr			$38,056.24		$5,082.00		
Week 2, 5 days*12hr+ 2 days*8hr			$38,056.24		$5,082.00		
Week 3, 5 days*12hr			$30,044.40		$5,082.00		
Week 4, 5 days*12hr			$30,044.40		$5,082.00		
Box Truck	$2,159.00					$50.00	
SUV	$2,992.50					$200.00	
Charter Boats/Crews							
Coral Queen with Capt, fuel, per diem	$55,500.00						
Chase Boat with driver, fuel	$22,500.00						
Shallow Water Survey Boat	$6,000.00						
Overnight Security	$4,500.00						
Equipment Maintenance	$5,000.00						
Consumables/Supplies	$2,000.00						
Subtotal	$100,651.50	$0.00	$136,201.28	$0.00	$20,328.00	$250.00	
TOTAL VIEQUES SURVEY OPERATIONS							**$257,430.78**
Demobilization							
Disassembly 3 men, 1 day			$3,153.04		$544.50		
Packout 3 men, 1 day			$3,153.04		$544.50		
Equip Transport Culebra/SJU (?)	$0.00			Paid by ACE			
Rent Car (2 days)	$350.00					$20.00	
Box Truck (3 days)	$225.00					$40.00	
Equip Transfer to Trailer (SJU)	$1,000.00		$1,051.01		$181.50		
Transport San Juan-Cary, 45 ft flatbed, Land Marine Cargo	$3,541.00						
2 men Culebra/SJU		$798.00					
2 men 2 day at SJU			$3,214.40	Airfare in Mob Costs	$363.00		
3 Charter Boats/Crews Culebra to Fajardo	$2,800.00						
Subtotal	$5,116.00	$798.00	$10,571.49		$1,633.50	$60.00	
TOTAL DEMOB COSTS (Equipment Ferry Costs, Transport Fajardo-SJU, Paid by ACE)							**$18,178.99**
Other Costs							
Demonstration Plan	$10,000.00						
HASP	$3,000.00						
Equipment Repair/Restocking	$15,000.00						
Develop Report	$20,000.00						
Subtotal	$48,000.00						
TOTAL OTHER COSTS							**$48,000.00**
GRAND TOTAL COSTS							**$386,704.39**

Table 8-2. All Operational and Survey Costs Associated with the Vieques Demonstration

COST ELEMENT	DATE	EXPENSE	SAIC LABOR, LODGING, PER DIEM	AIRFARE	SEA VENTURES CHARTER BOATS	SEA VENTURES, SECURITY	HARDWARE	EQUIPMENT RENTALS	TEST PLAN	OVERSEAS SHIPPING	DATA ANALYSIS	FINAL REPORT	SUBTOTAL
Pre TDY	Various	Test Plan Development							$20,000.00				$20,000.00
		Platform Fiberglass Reair	$1,481.44				$5,472.11						$6,953.55
		DAQ Computer Rebuild	$5,083.20				$2,272.00						$7,355.20
		Packout	$1,757.36				$136.32	$568.00					$2,461.68
		Cary NC to San Juan								$4,990.00			$4,990.00
		SeaVentures Ins. Rider			$21,253.83								$21,253.83
Total Pre TDY Costs													**$63,014.26**
Mobilization	Fri 6/1/07	Personnel	$3,067.04	$784.61									$3,851.65
		Box Truck						$1,916.99					$1,916.99
		Tractor, SJ/Fajardo						$451.67					$451.67
	Sat 6/2	Personnel	$3,059.04										$3,059.04
		Haul Queen			$1,828.10								$1,828.10
	Sun 6/3	Matl. For Buildout					$2,272.00						$2,272.00
		Personnel	$3,059.04										$3,059.04
		Queen Thru Hull				$562.50							$562.50
		Charter Costs			$664.77								$664.77
	Mon 6/4	Remaining Crew to Fajardo	$7,171.96	$1,099.56									$8,271.52
		Relaunch Queen			$715.90								$715.90
	Tue 6/5 Equip. to Esperanza	Cargo Ferry to Vieques								$576.72			$576.72
		Jeep Rental, Vieques						$3,716.74					$3,716.74
		Personnel	$7,225.65										$7,225.65
		Charters			$3,247.13	$153.41							$3,400.54
	Wed 6/6 Equip. to BSDS	Personnel	$7,249.52										$7,249.52
		Charters			$3,247.13	$153.41							$3,400.54
	Thu 6/7, Dusky Dead, Noon Depart, Survey Prep at BSDS	Personnel	$7,232.37										$7,232.37
		Charters			$3,247.13	$153.41							$3,400.54
	Fri 6/8, Range Demo., Boats Idle, Crashed TV Camera	Personnel	$7,210.90										$7,210.90
		Charters			$3,247.13	$153.41							$3,400.54
Total Mob Costs													**$73,467.24**

Table 8-2. Continued

COST ELEMENT	DATE	EXPENSE	SAIC LABOR, LODGING, PER DIEM	AIRFARE	SEA VENTURES CHARTER BOATS	SEA VENTURES, SECURITY	HARDWARE	EQUIPMENT RENTALS	TEST PLAN	OVERSEAS SHIPPING	DATA ANALYSIS	FINAL REPORT	SUBTOTAL
Survey	Sat 6/9, Sea Tow Chase Boat, Survey Noon Start	Personnel	$7,243.20										$7,243.20
		Charters			$3,247.13	$153.41							$3,400.54
	Sun 6/10, Sea Tow Chase Boat, Survey by 0830	Personnel	$7,204.80										$7,204.80
		Charters			$3,247.13	$153.41							$3,400.54
	Mon 6/11, Rusty Chase Boat, Survey by 0900	Personnel	$7,338.28										$7,338.28
		Charters			$3,247.13	$153.41							$3,400.54
	Tue 6/12, Sea Tow Chase Boat, Survey by 1100	Personnel	$7,189.92										$7,189.92
		Charters			$3,247.13	$153.41							$3,400.54
	Wed 6/13, Mags Broken, Queen Standby in BSDS, Skiff Survey	Personnel	$7,189.92										$7,189.92
		Charters			$2,045.44	$153.41							$2,198.85
	Thu 6/14, Mags Broken, Queen Standby in BSDS, Dusky Broke, No Survey	Personnel	$7,189.92										$7,189.92
		Charters			$971.58	$153.41							$1,124.99
	Fri 6/15, Queen/Platform to Esperanza, Dusky to Fajardo, No Survey	Personnel	$7,303.22										$7,303.22
		Charters			$2,416.19	$153.41							$2,569.60
	Sat 6/16, Queen & Skiff in Esperanza, Dusky in Fajardo, No Survey	Personnel	$6,002.36										$6,002.36
		Charters			$971.58	$153.41							$1,124.99
	Sun 6/17, Queen & Skiff in Esperanza, Dusky Returns, No Survey	Personnel	$6,002.36										$6,002.36
		Charters			$1,201.70	$153.41							$1,355.11
	Mon 6/18, All boats in Esperanza, No Survey	Personnel	$6,051.10										$6,051.10
		Charters			$1,201.70	$153.41							$1,355.11
	Tue 6/19, LCM from Astillerno, All boats to BSDS, 2 Hr of Survey	LCM Charter Platform to BSDS						$12,784.00					$12,784.00
		Personnel	$7,189.92										$7,189.92
		Charters			$3,247.13	$153.41							$3,400.54
	Wed 6/20, Queen Weather Standyby, Skiff Survey	Personnel	$7,189.92										$7,189.92
		Charters			$1,968.73	$153.41							$2,122.14
	Thu 6/21, Queen Weather Standyby, Skiff Survey	Personnel	$6,143.10										$6,143.10
		Charters			$1,968.73	$153.41							$2,122.14
	Fri 6/22, Bomb Demo Day, No Survey	Personnel	$6,413.71										$6,413.71
		Charters			$1,048.28	$153.41							$1,201.69

Table 8-2. Continued

COST ELEMENT	DATE	EXPENSE	SAIC LABOR, LODGING, PER DIEM	AIRFARE	SEA VENTURES CHARTER BOATS	SEA VENTURES, SECURITY	HARDWARE	EQUIPMENT RENTALS	TEST PLAN	OVERSEAS SHIPPING	DATA ANALYSIS	FINAL REPORT	SUBTOTAL
Survey	Sat 6/23, Skiff & MTA Surveys	Personnel	$7,213.05										$7,213.05
		Charters			$3,400.54	$153.41							$3,553.95
	Sun 6/24, MTA Survey	Personnel	$7,189.92										$7,189.92
		Charters			$3,400.54	$153.41							$3,553.95
	Mon 6/25, Skiff Survey	Personnel	$7,214.37										$7,214.37
		Charters			$3,400.54	$153.41							$3,553.95
	Tue 6/26, Dusky Dead, Overland to BSDS	Personnel	$7,209.22										$7,209.22
		Charters			$2,444.30	$153.41							$2,597.71
	Wed 6/27, Dusky Dead, Overland to BSDS	Personnel	$7,234.95										$7,234.95
		Charters			$2,444.30	$153.41							$2,597.71
Total Survey Costs													**$192,531.83**
Demobilization	Thu 6/28, LCM Jochi, All Boats to Esperanza	LCM Charter, Platform to Mosquito Pier						$16,874.88					$16,874.88
		Personnel	$7,357.36										$7,357.36
		Charters			$3,400.54	$153.41							$3,553.95
	Fri 6/29, All Boats to Fajardo, Long Term Standby	Interisland Ferry to Fajardo								$306.72			$306.72
		Personnel	$5,993.92										$5,993.92
		Charters			$3,400.54								$3,400.54
	Sat 6/30	SAIC Crew Return to US	$4,360.48	$2,877.92									$7,238.40
	7/18 End of Culebra Operation	All Boats to Fajardo	$6,894.16	$200.00									$7,094.16
		Jim & Nagi to US											$0.00
	7/19, Haul Queen, Pack out	Demob Queen			$2,556.80								$2,556.80
		Personnel	$3,059.44										$3,059.44
	7/20, Packout	Personnel	$2,321.03	$200.00									$2,521.03
		Shipping FDO/SJU								$340.80			$340.80
		Shipping SJU/Cary								$5,680.00			$5,680.00
	Cary Demob	Personnel	$1,757.36					$380.00					$2,137.36
Total Demob. Costs													**$68,115.36**
Post TDY	Data Analysis										$20,000.00		$20,000.00
	Demonstration Report											$30,000.00	$30,000.00
	Equipment Repair						$5,700.00						$5,700.00
Total Post TDY Costs													**$55,700.00**
Total Operation Cost													**$452,828.70**

8.2 Cost Benefit

There are currently no commercial platforms or commercial service companies providing underwater marine geophysical survey services similar to those demonstrated by the MTA over the past 4 years. By that we mean that there are no commercial service providers who can provide UXO detection and analysis capabilities based upon magnetic or electromagnetic sensor platforms that are used to comprehensively survey and map underwater areas for the presence of (buried or proud) UXO and to provide the survey results in a digital electronic format.

Currently underwater UXO detection and recovery operations are carried out by EOD or UXO dive teams using visual recognition and/or frequency domain hand-held metal detectors. Any discoveries must be either immediately prosecuted or marked with weights and buoys for later reacquisition. Creation of a digital survey product is not feasible, nor is it straight forward to comprehensively survey extensive areas using this approach.

There are currently two sensor platforms similar to the MTA arrays that have been demonstrated in realistic underwater UXO environments. These systems are relatively expensive to develop and manufacture, and they expensive to deploy. There are millions of acres of marine ranges (and other marine UXO-contaminated areas) that will potentially require characterization and remediation. To date there have been no underwater UXO investigations or clearances undertaken that are even vaguely similar in scope to the extensive land clearances that have taken place on many former land ranges.

Commercial organizations will not assume the costs of developing and commercially implementing technologies similar to the MTA until there is a firm commitment by the DoD to undertake investigations and clearances of a sufficient scope to justify the capital investment to deploy them.

9.0 IMPLEMENTATION ISSUES

9.1 Environmental Checklist

The environmental cleanup of the former VNTR on the eastern sector of Vieques Island began on January 10, 2000 under the Resource Conservation and Recovery Act (RCRA) 3008(h) Consent Order. The RCRA was established by Congress to address environmental problems due to hazardous waste on current and future sites. On April 30, 2001, the U.S Navy transferred approximately 4,000 acres of the former NASD to the municipality of Vieques, 3,100 acres to the U.S. Department of the Interior Fish and Wildlife Service (DOI), and 800 acres to the Puerto Rico Conservation Trust. On May 1, 2003, the Navy transferred 14,573 acres of the former VNTR on east Vieques to the U.S. Department of Interior (DOI) to be added to the Vieques National Wildlife Refuge, Figure 2.[7]

In 2003, the Navy conducted a munitions survey of both Bahia Corcho (Red Beach) and Bahia de la Chiva (Blue Beach). These beaches were then officially opened to the general public visiting the wildlife refuge. They were temporarily closed in 2004 after heavy storms washed munitions items from offshore onto the beaches.[8]

In 2005, the U.S. Environmental Protection Agency (EPA) placed the former VNTR and NASD areas of Vieques on the National Priorities List (NPL or "Superfund)." In addition to the environmental sites, there are 62 potential sites with munitions and explosives of concern (MEC) remaining on the former VNTR. Continuing cleanup on the site is being conducted under CERCLA guidelines following a Federal Facilities Agreement, which was developed and signed by the parties.[9]

The Navy conducted a *Preliminary Range Assessment and Phase I Extended Range Assessment* in 2005 to gather data on the quantity and type of munitions remaining on the site, to prioritize sites for further study, and to identify high risk sites that may require time-critical removal actions.[8] In April 2005, the Time Critical Removal Action (TCRA) began. The beaches and other high priority areas in the LIA were investigated and UXO items were identified and removed.

Present day operations on the eastern half of Vieques Island are all cleanup related. To date, all UXO cleanup operations are taking place on land. As of January 2006, two hundred and sixty seven acres of the former LIA have been surface cleared including 65 acres of beaches. During this process 2,500 live munitions items were recovered and over 125,000 munitions-related items were recovered.[9]

9.2 Other Regulatory Issues

All of our activities during this demonstration took place with the support and oversight of NAVFAC Lant, which is the office managing the cleanup operations on Vieques. During our preliminary visit to Vieques we met with and coordinated our intended activities with John Noles and Chris Penny (NAVFAC Lant) and their on-site contractors. We additionally met with the local environmental regulators (DNER) and the Region 2 staff of the National EPA office, and

with some local citizen's group representatives. Our test plan was made available in draft form to all these representatives for comment.

Additional confrontations that took place with local citizens and members of the Vieques City government during our sight operations were referred to NAVFAC Lant representatives and were handled by local NAVFAC Antilles public relations representatives.

9.3 End User Issues

The most likely end users of this technology are the commercial UXO service provider firms, in association with ACE/Huntsville and the Regional Offices of the Corps and individual DoD installation commanders. Other likely users include the various divisions of NAVFAC and Navy/Marine Corps installation managers who are responsible for training ranges with marine UXO contamination problems. The results of this demonstration were monitored by members of the Army Corps (Huntsville) and NAVFAC Lant.

The instrumentation used in this demonstration is a custom-built prototype. However, with a few exceptions, it has been constructed with COTS components. The unique components in the Marine Towed Array are the fiberglass sensor platform, the tow cable and underwater electronics housings, the EM68 sensor, the pilot guidance display and software, and some custom-designed printed circuit boards. Each of these components is fully documented and described in various reports, and could be purchased from the original manufacturers. There are no proprietary technologies embedded in the Marine Towed Array.

9.4 Availability of the Technology

The complete MTA system remains the property of ESTCP. It is housed and maintained by SAIC at our facilities in Cary, NC. It is operational and available to support other demonstration surveys sanctioned by ESTCP.

SAIC independently owns all the equipment necessary to conduct very shallow water marine surveys. This includes a survey vessel, GPS navigation/location equipment, an array of marine magnetometers, and a Maglog-based data acquisition system. We can independently support very shallow water marine UXO survey operations.

10.0 REFERENCES

1. http://www.vieques-island.com/navy/

2. http://epa.gov/region2/vieques/index.html

3. http://public.lantops-ir.org/sites/public/vieques/East%20Site%20Info/about.aspx

4. UX-1322 SERDP Project, http://www.serdp.org/research/UXO.html

5. "Technology Needs for Underwater UXO Search and Discrimination," Final Report SERDP Project UX-1322, http://docs.serdp-estcp.org/viewfile.cfm?Doc=UX%2D1322%2DFR%2D01%2Epdf

6. ESTCP Project 200324, http://www.estcp.org/projects/uxo/UX-0324o.cfm

7. "Marine Towed Array Technology Demonstration at the Former Naval Duck Target Facility," Final Report 21 November 2005

8. "Demonstration of the Marine Towed Array on Ostrich Bay at the Former Naval Ammunition Depot – Puget Sound, June 12-30, 2006," ESTCP Project MM2003-24, Final Report, September 20, 2008

9. "Explosives Safety Submission/Site Approval Request, Former Vieques Naval Training Range (VNTR) Vieques, Puerto Rico," Contract Task Order 047, LANTDIV CLEAN III Program, Contract N62470-02-D-3052, CH2M Hill, December 2006

10. "Vieques Underwater Unexploded Ordnance Demonstration Project – Project Plan," NOAA Navigation Response Team S3004, November 2006

11. "Marine Towed Array Technology Demonstration Plan for Vieques Island, PR – ESTCP Project No. 2003-24," Final Draft, May 30, 2007

12. "Health and Safety Plan for the Vieques Underwater Unexploded Ordnance Demonstration Project, Vieques Island, Puerto Rico," NOAA, Nov. 2006

13. "The MTA UXO Survey and Target Recovery on Lake Erie at the Former Erie Army Depot – ESTCP Project MM2003-24," Final Report January 25, 2007

14. Ken Deslarzes, Robert Nawojchik, and David Evans, "Ex-USS Killen Site Investigation and Biological Characterization, Vieques Island, Naval Station Roosevelt Roads, Puerto Rico," Final Report Contract No. N62470-95-D-1160, Naval Facilities Engineering Command, Atlantic Division, Geo-Marine, Inc., June 2002

APPENDIX A: POINTS OF CONTACT

Organization	Point of Contact	Role in Project	Phone/Fax/Email
ESTCP 901 North Stuart St. Suite 303 Arlington, VA 22203	Jeffrey Marqusee	Director, ESTCP	Tel: 703-696-2120 Fax: 703-696-2124 Email: jeffrey.marqusee@osd.mil
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	Chris Penny	Remedial Project Manager	Tel: 757-322-4815 Cell: 757-748-4043 Fax: 757-xxx-xxxx Email: christopher.penny@navy.mil
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	Pedro Rodriguez	Marina Puerto Del Rey Hwy 3 Km 51.2 Fajardo, PR 00738	Tel: 800-739-3483 Cell: 787-342-6952 Email: pedroscuba@onelinkpr.net
Crowley Liner Services	Roseann Goodale	Barge: Jacksonville, FL to Puerto Rico	Tel: 800-276-9539 Fax: 904-727-4065 PR Tel:787-729-1300 Fax: 787-729-1332

8. POINTS OF CONTACT, Continued

US Army Corps of Engineers, PO Box 1600 Huntsville, AL 35807	Rodger Young	CEHNC-ED-SY-T	Tel: 256-895-1629 Fax: 256-722-8709 Roger.J.Young@hnd.usace.army.mil
	Andrew B. Schwartz	CEHNC-ED-SC-G	Tel: 256-895-1644 Fax: 256-XXX-XXXX andrew.b.schwartz@hnd01.usace.army.mil
US Army Corps of Engineers, Jacksonville Dist.	Wandell Carlton	FUDS Prog. Mgr. Culebra	
US Army Corps of Engineers Antilles Office 400 Fernandez Juncos San Juan, PR 00901	Jose Mendez	FUDS Prog. Mgr. Culebra	Tel: 787-729-6893 X 3099 jose.mendez@sajo2.usace.army.mil
US EPA Vieques Field Office P.O. 1537 Vieques, Puerto Rico 00765	Daniel Rodriguez	Remedial Project Manager	Tel: 787-741-5201 Email: Rodriguez.Daniel@epa.gov
Puerto Rico Environmental Quality Board 431 Ponce de Leon Ave. Hato Rey, PR 00917	Yarissa A. Martinez	Culebra and Vieques Affairs Coordinator	Tel: 787-767-8181 Email: yarissamartinez@jca.gobierno.pr
US Fish & Wildlife Service PO Box 1527 Vieques, PR 00765		Vieques National Wildlife Refuge Manager	Tel: 787-741-2138 Email: caribbbeanisland@fws.gov

APPENDIX B – CHARTER VESSEL DOCUMENTS

SAIC
Advanced Sensors & Analysis Division

Jim R. McDonald, P.I.
120 Quade Drive
Cary, NC 27513

STATEMENT OF WORK
Dated April 9, 2007
for Required Marine Charter Support for the
MTA UXO Demonstration Survey
on the Islands of Vieques and Culebra, Puerto Rico,
June and July 2007

STATEMENT OF WORK

1. BACKGROUND: During approximately the past 50 years parts of the islands of Vieques and Culebra, off the east coast of Puerto Rico have been used as training and maneuver areas primarily by the US DoD, but also in conjunction with NATO allies. The islands have been used for ground-to-ground and air-to-ground weapons testing and training, and by naval vessels for ship-to-shore training. There are numerous gun emplacements and target areas defined on each of the islands and range fans include significant offshore areas of these islands, particularly in bays and estuaries. Ordnance that has been fired or dropped includes the full range of sizes (20 mm projectiles to Mk84 GP bombs, rockets, mortars, and submunitions). DoD training ended several years ago on each of the islands. UXO clearance is currently underway on land on each island. Ownership of the former range and training areas either has or is in the process of being returned to a variety of stakeholders including local groups and agencies in Puerto Rico as well as the US Fish and Wildlife Service, Department of Interior and other non-DoD agencies. Stewardship and cleanup responsibilities for Vieques lie with the US Navy (NAVFAC Lant) and on Culebra with the US Army (Corps of Engineers).

As a result of environmental investigations (primarily of the coral reefs) it is known that there is significant offshore MEC contamination within the bays and estuaries of each island in the areas formerly associated with the active ranges. Many of these areas are bounded by white sand beaches and relatively shallow water offshore areas dominated by fringing coral reefs. There are two shipwrecks within the Bahia Salinas del Sur off the Vieques LIA. These protected bays are popular areas for recreational divers and weekend parking of yachts and pleasure boats. This is in spite of the fact that most of these areas are posted as off limits because of known and suspected UXO contamination.

Recently NOAA NMSP conducted exploratory demonstration geophysical surveys of some of the offshore areas associated with the Vieques and Culebra Ranges. Laser Lidar bathymetry, side scan sonar, video cameras, and limited magnetometry measurements were made from surface vessels and ROVs in selected bays.

During the months of June and July 2007 SAIC, with support from ESTCP, NOSSA, NAVFAC Lant., and the Army Corps of Engineers Huntsville, will conduct a demonstration UXO geophysical survey of selected offshore areas of Vieques and Culebra. The SAIC Marine Towed Array demonstration will include areas of complete (100%) survey area coverage and areas that will be characterized by transect surveys on survey grids with widely separated, but precisely spaced, parallel survey lanes.

The mechanical and operational description of the MTA is provided in extensive detail in the MTA Demonstration Test Plan, which is a companion document to this SOW. Briefly, the MTA sensors reside on a 5-meter wide wing shaped submerged platform, which is towed behind a surface vessel using a 20-meter tow cable. The sensor platform is designed to fly through the water at a fixed height above the bottom (typically 1.5 meters) under autopilot computer control from the surface vessel. The surface vessel is guided along the individual survey grid lines by the boat operator following direction from a pilot guidance display unit in the cockpit console.

In the previous four MTA demonstration surveys, the tow vessel has been a 30-foot open deck pontoon boat. The originally-developed MTA system was designed to operate in Sea State 1 at water depths between 3 and 15 feet. Alterations have been made to the system that allow operation with surface conditions approaching Sea State 2 and at depths of up to 30 feet. Rougher seas and deeper water conditions limit survey speed and production rates.

Employees of SAIC made a reconnaissance trip to the islands of Puerto Rico and Vieques during December of 2006. We investigated dive boat and fishing boat charter operations on the eastern shore of Puerto Rico and interviewed owners and captains of vessels and made measurements on individual vessels to determine their suitability for our needs. We identified the most appropriate vendor who can provide suitable vessels, can carryout the required modifications, provide appropriate captains and crew, and who is available for the period required for the demonstration. The dive boat operator is Sea Ventures of Fajardo, Puerto Rico. The primary vessel is the Coral Queen, which is available.

In addition we flew to Vieques and chartered a small vessel that we used to circumnavigate the island of Vieques. We investigated the primary areas of interest for the demonstration, identified the assembly and launch area, established the required areas where moorings for overnight tie-up must be established, and positions for installation of GPS control points.

2. SCOPE OF WORK: Because this demonstration will take place very far from our North Carolina base and because much of it will take place in open ocean waters, we decided to use a charter vessel of opportunity at the site of the demonstration. This will require that the charter vessel be significantly altered and built out to accommodate the survey components typically located on and deployed from the MTA tow vessel deck. Additionally, we will require two further vessels to support the demonstration. The second vessel will serve as a support/chase boat tending the MTA survey vessel. The chase boat will also provide high speed ferry between the survey area and the overnight accommodations. The third boat will support an additional magnetometer sensor array to survey in extremely shallow areas and in shallow areas dominated by coral reefs and coral heads. These vessel characteristics and requirements are described more extensively in a latter section.

Task 1. Build out: Beginning 1 June the contractor shall provide the primary tow vessel and the very shallow water survey boat (third boat) for build out to support the survey mission. It is presumed that the build out will take place at the home marina of the tow vessel and that the crew, the mate, and other contractor personnel will be provided (as required) to support these build out activities. On the tow vessel, bolt down fixtures (or plates) are required to mount the SAIC-supplied components including the tow point fixture, GPS antenna mounts, cable take-up fixture, sonar depth gauge, and Didson Imaging Sonar. These components are shown in graphics and photos attached to the SOW. The shallow water vessel will be built out to accommodate three magnetometers, two GPS antennas, and a shelter for the PC controller. An image of another boat is shown outfitted similarly to that required here. The contractor may be required to identify access to machine shops, welders, sheet aluminum, dimensional lumber, and hardware (marine shackles, non-metallic screws, bolts, etc). SAIC will provide two support personnel to assist and guide the build out process. It is anticipated that it will take 3 days.

Task 2. ***Ferry to Vieques:*** All three vessels will be ferried to Vieques and anchored off the boat launch ramp at Esperanza. This will take place on approximately 4 June. SAIC will transport all support equipment and the sensor platform (on a boat trailer) to Esperanza. The sensor platform will be assembled on shore, launched and mated to the primary tow vessel. All three vessels will be ferried from Esperanza to the primary mooring points in Bahia Salinas del Sur. It is anticipated that these operations will be completed on 4 and 5 June.

Task 3. ***MTA Survey of Bahia Salinas del Sur:*** Beginning about 6 June survey operations on the bay will begin. SAIC shall provide the operator for the shallow water survey vessel. The contractor shall provide the operator and mate (if required) for the other two vessels. Survey operations shall continue through the weekend of 9 and 10 June. On weekdays, operations will begin in Esperanza at 0530 at a tailgate safety meeting with the Vieques Site Safety Officer, an employee of CH2M-Hill. The SAIC and contractor crews will proceed from Esperanza to the survey site to begin survey operations following the safety meeting. On Saturdays and Sundays there will be no tailgate meeting in Esperanza. At the end of the survey day the MTA tow vessel and the shallow water tow vessel will be moored at provided sites in the bay. Following down load of all data and securing of all equipment, the SAIC and contractor crew will be transported to Esperanza in the chase boat. One contractor crew member will remain behind on the tow vessel to provide overnight security. During the survey day the chase boat will remain primarily in a standby mode to respond to the tow vessel, if required.

Work on the weekend of 16-17 June will be made as a field decision by SAIC and will depend upon time lost during the previous week to weather, mechanical delays, or ordnance operations on land. It is anticipated that survey operations in Bahia Salinas del Sur will be completed on or about 22 June.

Task 4. ***Ferry to Bahia Salinas/Bahia Icacos:*** Following completion of survey operations on the south side of Vieques the contractor shall ferry the three vessels to Bahia Icacos and tie them up at the provided mooring points. The survey platform shall remain mated to the tow vessel during the ferry; therefore speed will be limited, likely to 2 m/sec and the ferry may have to be delayed until appropriate wave conditions prevail off the east coast of Vieques. It is anticipated that the ferry will take place on or about 23 or 24 June.

Task 5. ***Survey of Bahia Icacos/Bahia Salinas:*** During the week of 25-29 June survey operations on these bays will be completed. In the evenings the two survey vessels shall be tied up at the provided mooring points and the chase boat will ferry the SAIC and contractor crews to an appropriate docking point on the north side of the island to access the overnight accommodations. One contractor crew member will remain overnight on the tow vessel to provide security. Tailgate safety meetings will take place at 0530 at the dock.

Task 6. ***Ferry to Culebra:*** Following completion of survey operations on the north side of Vieques, the contractor shall ferry the three vessels to from Vieques to Culebra. Depending upon the condition and operation of the survey platform components SAIC may or may not wish to disassemble the platform from the tow vessel. The contractor should be prepared to ferry the tow vessel to Culebra either with or without the platform attached. In

Culebra the vessels will be tied up at moorings provided in a sheltered area between the Cayo de Luis Peña and the mainland.

Task 7. ***Standby (Tentative):*** It may be that SAIC will wish to suspend operations for the week of 1 July. If operations are suspended, the contractor vessels will remain in standby mode on Culebra for this period until operations begin again. If SAIC suspends operations on 30 June, operations will begin again on 9 July.

Task 8. ***Survey operations on Culebra:*** Survey operations on Culebra will be conducted as a series of long transect surveys around the Cayo de Luis Peña and along the adjacent coast of Culebra. Each evening the two survey vessels will be tied up at a suitable mooring point provided by the Army Corps of Engineers and the chase boat will ferry SAIC and contractor crews to a suitable dock on Culebra to access overnight accommodations. One contractor crew member shall remain on the primary tow vessel to provide security. Survey operations shall begin each morning at 0530 at the dock for departure to the survey vessel. It is anticipated that survey operations will be completed on Culebra between 9 and 13 July.

Task 9. ***Ferry to Fajardo:*** The survey vessel shall be moored or docked at a suitable point in Culebra where the sensor platform shall be disconnected and placed upon the transport trailer (boat trailer). The box truck with the SAIC equipment and the sensor platform trailer will be transported to Fajardo by cargo ferry. The 3 contractor vessels shall be ferried to the contractor marina in Fajardo for disassembly. It is anticipated that these operations shall take place on 13 and 14 July.

Task 10. ***Demobilization:*** Working together SAIC and contractor personnel shall disassemble all components from the contractor vessels and return the vessels to precharter conditions. The vessels will be returned to the contractor. All SAIC materials and components shall be packed into the shipping containers and loaded onto the box truck for transport to San Juan. It is anticipated that these operations shall be completed on 15 and 16 July.

3. DELIVERABLES:

3.1 Vessels: The contractor shall provide three vessels that are suitable to support this operation.

Vessel 1 is the tow vessel. The tow vessel will be the Coral Queen (or other equivalent vessel), which will be suitable to support all MTA survey operations.

Vessel 2 is the chase boat. The chase boat is the support vessel (chase boat) for the MTA survey vessel. It also provides ferry back and forth each day for the SAIC and contractor crews from the dock point to the survey mooring points. It must accommodate 6-8 people, provisions, and fuel to support the other vessels. It should have a cabin to provide some protection from the weather.

Vessel 3 is the shallow water survey boat. It should be a flat bottom fiberglass boat with a bottom that is at least 6 feet wide forward of the forward seat. The vessel should be 19-22 feet long with minimal ferrous attachments or other hardware (particularly forward). It should be powered by a modest outboard engine and supported by a non-ferrous gas tank.

3.2 Build out Support: The contractor shall provide personnel, equipment, materials, and tools at his Fajardo Marina facility to satisfactorily complete the build out operations described above for the MTA tow vessel and the shallow water survey vessel. Satisfactory completion of the build out will be defined as SAIC acceptance of the build out effort.

3.3 Delivery of Vessels to Vieques: The contractor shall successfully complete delivery of the survey vessels to Esperanza, support the mating of the sensor platform to the MTA tow vessel, and the delivery of all three survey vessels to the provided mooring points in the Bahia Salinas del Sur. All vessels shall be delivered in fully operational condition.

3.4 Survey Performance: The contractor shall demonstrate the ability to survey to the grid lines provided on the pilot guidance display beside the helm. Satisfactory performance is defined as the ability to pilot the vessel on a 4-meter grid line spacing with essentially no survey gaps or missed survey areas. It is assumed that one day of training and practice may be needed to become facile at piloting the boat to the provided survey lanes. The pilot must also display the ability to promptly respond to instructions from the SAIC crew member who is monitoring the incoming data and conditions and to breaking of the weak link resulting from impact of the sensor platform with bottom obstructions. Failure to instantly respond will result in snatching the tow cable connectors from their bulkhead connectors, requiring recovery of the platform, cleaning of the cable connectors and remating of the connectors.

3.5 Ferry to Icacos: The contractor shall successfully ferry the three vessels from Bahia Salinas del Sur and delivering them to the provided mooring points in the Bahia Icacos. All vessels shall be delivered in fully operational condition.

3.6 Ferry to Culebra: Following completion of surveys in the Bahia Salinas and Bahia Icacos the contractor shall successfully ferry the three vessels from Bahia Salinas and deliver them to the provided mooring points adjacent to Culebra. All vessels shall be delivered in fully operational condition.

3.7 Ferry to Fajardo: Following completion of surveys on Culebra, the contractor shall support unmating of the survey platform and loading the platform on the boat trailer. Following the unmating of the platform, the contractor shall successfully deliver the three vessels to his home marina in Fajardo on the main island.

3.8 Crew, vessels and ancillary support: The contractor shall provide all crew (captains and mates) required to support his vessels in this operation. The contractor is responsible for providing accommodations and per diem support for the crew. The contractor shall provide overnight security for his vessels and all SAIC equipment. The contractor shall provide all fuel necessary to support this operation and deliver it as needed to the survey vessels. The SAIC generators require ~10 gal/day of regular gasoline. The contractor shall provide bottled water to support all SAIC and contractor crew for all operations. The contractor shall provide all necessary maintenance and housekeeping support to maintain all vessels in fully operational condition through out the operation.

4. ACCEPTANCE CRITERIA: Acceptance criteria are defined in Section for each primary deliverable.

5. PAYMENT: The specific payment schedule and terms will be stated in the contract document. In general, SAIC expects that an initial payment will be made upon signing of the contract that will support all costs associated with the vessel support and build out operations defined in Tasks 1 and 2 in Section 2 above. The initial payment will also cover costs associated with delivery of the vessels to the mooring points in Vieques (Task 2).

During the course of the operation progress payments will be made in accordance with a schedule that will be defined in the subcontract document.

A final payment will be made based upon the final invoice, which will be submitted by the contractor following his acceptance of the return of the vessels following demobilization operations (Task 10).

6. PERIOD OF OPERATION: Nominally, the period of performance is scheduled to take place between 1 June and 16 July 2007. The contractor should provide costing based upon this period of performance assumption and the performance details described above. The contractor should also provide costing information for extended survey operations (resulting from weather, breakdowns, or changes in scope) on a per day basis (assuming routing survey operations as described above).

7. PLACE OF PERFORMANCE: A planned activities take place at the contractor's marina on Puerto Rico or on the islands of Vieques or Culebra and in the shallow waters around Vieques and Culebra.

8. CUSTOMER FURNISHED EQUIPMENT/INFORMATION: Contractor provided equipment includes the three vessels described above, the crew to support and man these vessels, support equipment described in Task 1 in Section 2, and ancillary equipment and materials described in Deliverable 3.8 in Section 3.

9. CONTRACT TYPE: A Time and Materials subcontract is most appropriated for this action.

10. APPLICABLE DOCUMENTS: The applicable documents are this SOW and the "Marine Towed Array Technology Demonstration Plan for Vieques Island, PR," (issued in draft form on 4 April 2007.

11. SUBCONTRACT REQUIREMENTS: The task requirements to be completed by SAIC and the contractor are described in Sections 1 and 2 of this document.

12. PROPERTY RIGHTS: Not addressed in this document.

13. TECHNICAL POINTS OF CONTACT:

SAIC:

Jim McDonald, P.I.
120 Quade Dr.
Cary, NC 27513
Tel: 919-653-0215 X 102
Cell: 919-673-6805
Fax: 919-653-0219
Jimmie.R.McDonald@saic.com

Chester Bassani
120 Quade Dr.
Cary, NC 27513
Tel: 919-653-0215 X 105
Cell: 919-244-4637
bassanic@saic.com

Sea Ventures

Pete Seufert, President
PO Box 70002
Fajardo, PR 00738
Tel: 800-739-3483
Cell: 787-502-1240
SeaVentures@divepuertorico.com

Pedro Rodriguez, Marketing Manager
Marina Puerto Del Rey
Hwy 3 Km 51.2
Farjardo, PR 00738
Tel: 800-739-3483
Cell: 787-342-6952
pedroscuba@onelinkpr.net

14. QUALITY REQUIREMENTS:

15. WARRANTY REQUIREMENTS:

16. SECURITY REQUIREMENTS: There are no security requirements associated with this demonstration; no security clearances are required, no classified information is involved, and no export sensitive information is involved.

17. SPECIAL REQUIREMENTS:

18. ATTACHMENTS/EXHIBITS: Several graphics and photographs are attached that illustrate the SAIC equipment that will be integrated into or onto the contractor vessels.

Figure 1. The assembled sensor platform is shown floating beside the tow boat.

Figure 2. Sea Ventures vessel, the Coral Queen. This is the presumed vessel that will be the tow boat for the MTA surveys.

Figure 3. View from inside the MTA showing the right tow cable take-up fixture (aluminum box). To the left is the center mounting pad for the tow point fixture.

Figure 4. View from the back of the MTA tow boat showing the cable take-up fixtures and the cable bulkhead connectors.

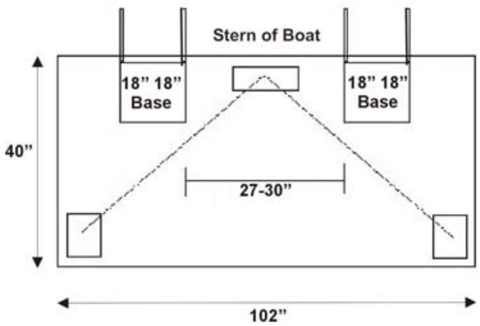

Figure 5. Schematic representation of the mounting positions for the cable take-up and the tow point pads.

Figure 6. The two racks that control the sensor platform and all the data acquisition are shown. On the Coral Queen they will be located in the main cabin.

Figure 7. The pilot guidance display is shown on the right of the driver and the forward depth sounder on the left. On the Coral Queen these readouts will be located on the topside console.

Figure 8. The tow arm assembly (with the weak link) is shown. Above the tow arm is the mount for the rear GPS unit.

Figure 9. A small flat bottom boat is show with mounting fixtures for 3 magnetometers and the GPS antennas. The plywood box houses the data computer.

SEA VENTURES, INC. PO Box 1202 Fajardo, PR
PH: 787-502-1240 FAX: 787-863-0199
www.DivePuertoRico.com

Date: 14 April 2007

From: Peter Seufert, President
Sea Ventures, Inc.
PO Box 1202 Fajardo, PR 00738

To: Carmen Foreman, Sr. Subcontract Administrator
Science Applications International Corporation
4001 North Fairfax Drive, Suite 410
Arlington, VA 22203

SUBJ: RFP No. CAF-549-041907 MTA UXO Demonstration Survey – on the islands of Vieques and Culebra, Puerto Rico.

Ms. Foreman,

Sea Ventures, Inc respectfully submits our quotation to provide charter vessel support services for Science Applications International Corporation (SAIC) MTA UXO Demonstration Survey in the waters off of Vieques and Culebra islands, Puerto Rico.

Sea Ventures, Inc. submits the following enclosures with this quote:

- Fixed Price Daily Rates tables – M/V Coral Queen, M/V Explorer & Carolina Skiff
- Government Property Questionnaire
- SAIC Vendor Master Data Template
- SAIC Vesel Time Chartering Agreement
- Vessel Specifications ("Annex A")
-

The validity period of this offer is 120 days from the date of submission.

Respectfully submitted,

Peter Seufert
Sea Ventures, Inc.

Section I - Approach

Identifications and qualifications of pertinent personnel:

General: Sea Ventures, Inc. crew are subject to and meet the requirements of US Department of Transportation (DOT), The Omnibus Transportation Employee Testing Act of 1991. As company sponsored members of the Maritime Consortium, the boat crews and support staff of Sea Ventures, Inc are subject to pre-hire and random drug and alcohol screening.

Sea Ventures, Inc. boat crews inclusive of our Captains, are certified PADI (Professional Association of Diving Instructors) DiveMasters or Instructors, - to include two Master Instructors. As a requirement of Sea Ventures, Inc. and PADI, each crew member carries professional liability insurance.

All Sea Ventures, Inc. staff are First Responder and Oxygen Provider trained. Each vessel is equipped with emergency first aid equipment and emergency oxygen kits.

Sea Ventures, Inc. vessels are all US Coast Guard inspected & documented vessels. Each vessel in the inventory is USCG Certified for a minimum of 20 divers. Vessels are individually insured for both hull & liability.

Vessel Captain (M/V Coral Queen) :
Mr. William Winnie holds a 100 ton Master US Coast Guard Captain License. License Number 1140026. William also carries US Coast Guard STCW-95 and the SCC endorsement (#MP00008157).
As a Master Diving Instructor with over 25 years of instructing experience, William has an impressive list of credentials: He is a certified PDIC Diving Instructor Trainer (#5476), NASDS Diving Instructor Trainer (#85), ISEA Instructor Trainer (#321), a PADI Instructor (#164627), a PADI CPR/AED/First Aid Emergency First Responder Instructor (#164627) a NAUI Instructor (#40842), a TDI (Nitrox) Enriched Air Instructor (#724) and a Certified Breathing Gas Blender Technician.
William Winnie is a seasoned member of the Sea Ventures team of over 11 years. He is the lead Captain for the company, overseeing the operations of four Sea Ventures boats and crews. He has provided professional diving and Captain services throughout the waters of Puerto Rico and the US Virgin Islands for this company.
Bilingual (English/Spanish), William is a resident of Caguas, Puerto Rico (Central Puerto Rico).

**** Backup Captain (M/V Coqui II) :**
Mr. Rafael Rodriguez holds a 100 ton Master US Coast Guard Captain License. License Number 1068519. Rafael Rodriguez is a qualified megayacht Captain with several years of international waters experience. Rafael is also a PADI certified Divemaster. He is a resident of Guanica, Puerto Rico (Southwest Puerto Rico).

Rafael Rodriguez is a seasoned member of over 9 years with the Sea Ventures team. He has provided professional diving and Captain services throughout the waters of Puerto Rico and the

US Virgin Islands for this company. Rafael is fully bilingual (speaks, reads & writes) English and Spanish.

DiveMaster (M/V Coral Queen) :
Mr. Pedro Rodriguez is a PADI certified DiveMaster. PADI licence number 180093. Perdo has over 14 years of DiveMaster experience, almost all of those years exclusively with Sea Ventures, Inc. He is a resident of Humacao, Puerto Rico (Southeast Puerto Rico).

Pedro has extensive experience in Caribbean conservation and reef restoration projects. He has been the lead DiveMaster and technical assistant for a number of turtlegrass mitigation projects, staghorn coral (Acropora Cervicornis) restoration efforts, vessel grounding investigations, artificial reef projects, soil/water sampling and marine surveys. He is fully bilingual (speaks, reads & writes) English and Spanish.

**** Backup DiveMaster (M/V Coqui II) :**
Mr. Tony Rosario holds a 100 ton US Coast Guard License. License Number 10881147. He is one of several qualified backup Captains for Sea Ventures. Tony is also a PADI certified Master Scuba Instructor. PADI license number 187191. In his eleven years as an instructor, Tony has certified 1,322 persons in scuba. He is a resident of Coamo, Puerto Rico (Southcentral Puerto Rico).

Tony has been involved in D.R.N. (Departmento Recourso Naturale) buoy installation efforts as well as several conservation and reef restoration projects, the most recent of which was the staghorn coral restoration effort in Guayanilla Bay, Puerto Rico. He is fully bilingual (speaks, reads & writes) English and Spanish.

President, Sea Ventures, Inc.
Mr. Peter Seufert has been involved in a wide variety of ocean studies and work throughout his 22 year Naval career. Starting with a 4 year tour supporting experimental deep submersible operations with the US Navy NR1 and DSRV (Deep Submergence Rescue Vehicle), as well as oceanographic studies (Scripps) involving submersibles Alvin & Trieste, - through to his last assignment as the EMO for SEAL/submarine inter-operability training exercises (conducted in waters off of Puerto Rico). He is an IDEA & NASE Instructor with over 25 years of diving instruction experience.

Peter started Sea Ventures 18 years ago and has successfully grown the company to its current position in the instructional, sport & commercial diving, marine logistics and diving support equipment retail industries.

Technical Management:

Captain William Winnie will be responsible for the safe operation and daily delivery/redelivery of the 28 foot support vessel M/V Explorer to and from the Bahia Salina Del Sur area of operation as described by SAIC.

Commencing 01 June 2007 through to the anticipated demonstration conclusion in early July 2007, - M/V Coral Queen will be exclusively available in support of the SAIC towed array technology demonstration. Captain Winnie will pilot the M/V Coral Queen, performing towing maneuvers as directed by SAIC officials daily for the duration of the demonstration.

DiveMaster Pedro Rodriguez will perform duties as First Mate and as primary DiveMaster (as may be required in support of operations). He will be responsible for chase-boat (M/V Explorer) operations during demonstration periods – responding to SAIC officials and Captain Winnie.

Pedro will also provide a security presence onboard M/V Coral Queen each night that this vessel remains behind in the Bahia Salina Del Sur area of operation.

Section II - Past Performance

General:

Sea Ventures, Inc. has successfully provided combined and individual technical, diving and logistics support for a variety of contractors. The largest of these performed during the last three years are listed below:

- CH2M Hill
- Continental Shelf Associates
- Departmento Recoursos Naturale De Puerto Rico
- Geo-Marine, Inc.
- NOAA
- USA Environmental, Inc.
- US Navy

Safety:

- In our 18 plus years in business, Sea Ventures, Inc. has ensured a safe diving experience for over 56,000 sport divers. Collectively we have provided incident free instruction and certification to 10,214 student divers.
- Commercially we have provided diving and marine logistics support throughout the waters of Puerto Rico and the US Virgin Islands with a perfect safety record of zero injuries and no major incidents.
- Our Emergency Dive Plan is closely fashioned after the NOAA model.
- Sea Ventures compressed breathing air is regularly tested by a certified laboratory.
- Sea Ventures is subject to the safety rules and laws of the following as they pertain to the diving, instruction and logistics activities of this company:
    - US Department of Transportation
    - US Coast Guard
    - Commonwealth of Puerto Rico

- Public Service Commission
- Professional Association of Diving Instructors
- Department of Natural Resources

Section III - Pricing (firm fixed price)

MV Coral Queen

Fixed Price CLINS	
CLIN 001 Fixed Day Rate Mob/Demob (Dockside) Home Port	600.00
CLIN 002 Fixed Day Rate Mob/Demob (Dockside at other than Home Port)	850.00
CLIN 003-Fixed Price Vessel Haul/Re-launch for Transducer Installation	1,650.00
CLIN 004- Fixed Price Vessel Haul/Re-launch -Transd/Underhull Mount Removal	1,650.00
CLIN 005-Fixed Price -Underhull Transducer Mod Install	550.00
CLIN 006-Fixed Price Underhull Transducer Mount Removal/Hull Restoration	250.00
CLIN 007-Fixed Day Rate during Vessel Haul and Re-launch Period	100.00
CLIN 008-Fixed Day Rate for Operational Day (at sea)	1,850.00
CLIN 009- Fixed Day Rate for in Port Stand-by	600.00
CLIN 010-Fixed Day Rate Long Term Shutdown-Vessel Home Port	150.00
CLIN 011-Fixed Day Rate Long Term Shutdown at other Port	275.00
CLIN 012-Rate pp Meals & Accommodations for Scientific Crew	???
Cost Reimbursable CLINS SECURITY GUARD	150/DAY
CLIN 014 - Estimated Fuel Charges	*160.00/DAY
CLIN 015 - Lube Charges per day	5.00/DAY
G&A on ODCs and consumables	
* No G&A on fuel/lubes	

Sea Ventures, Inc. has determined the firm fixed prices for the required vessels and support services during the requested period of 01 June 2007 through to the anticipated demonstration conclusion in early July 2007. These are listed in the attached Fixed Price Daily Rates tables.

MV Explorer (Support Vessel)

Fixed Price CLINS	
CLIN 001 Fixed Day Rate Mob/Demob (Dockside) Home Port	N/A
CLIN 002 Fixed Day Rate Mob/Demob (Dockside at other than Home Port)	Ø
CLIN 003-Fixed Price Vessel Haul/Re-launch for Transducer Installation	N/A
CLIN 004- Fixed Price Vessel Haul/Re-launch -Transd/Underhull Mount Removal	N/A
CLIN 005-Fixed Price -Underhull Transducer Mod Install	N/A
CLIN 006-Fixed Price Underhull Transducer Mount Removal/Hull Restoration	N/A
CLIN 007-Fixed Day Rate during Vessel Haul and Re-launch Period	N/A
CLIN 008-Fixed Day Rate for Operational Day (at sea)	750.00
CLIN 009- Fixed Day Rate for in Port Stand-by	75.00
CLIN 010-Fixed Day Rate Long Term Shutdown-Vessel Home Port	Ø
CLIN 011-Fixed Day Rate Long Term Shutdown at other Port	Ø
CLIN 012-Rate pp Meals & Accommodations for Scientific Crew	N/A
Cost Reimbursable CLINS	
CLIN 014 - Estimated Fuel Charges	30.00/DAY
CLIN 015 - Lube Charges per day	5.00/DAY
G&A on ODCs and consumables	Ø
* No G&A on fuel/lubes	

MV Carolina Skiff (Chase Boat)

17' W/ 60HP 4-STROKE Fixed Price CLINS	
CLIN 001 Fixed Day Rate Mob/Demob (Dockside) Home Port	N/A
CLIN 002 Fixed Day Rate Mob/Demob (Dockside at other than Home Port)	Ø
CLIN 003-Fixed Price Vessel Haul/Re-launch for Transducer Installation	N/A
CLIN 004- Fixed Price Vessel Haul/Re-launch -Transd/Underhull Mount Removal	N/A
CLIN 005-Fixed Price -Underhull Transducer Mod Install	N/A
CLIN 006-Fixed Price Underhull Transducer Mount Removal/Hull Restoration	N/A
CLIN 007-Fixed Day Rate during Vessel Haul and Re-launch Period	N/A
CLIN 008-Fixed Day Rate for Operational Day (at sea)	350.00
CLIN 009- Fixed Day Rate for in Port Stand-by	25.00
CLIN 010-Fixed Day Rate Long Term Shutdown-Vessel Home Port	Ø
CLIN 011-Fixed Day Rate Long Term Shutdown at other Port	Ø
CLIN 012-Rate pp Meals & Accommodations for Scientific Crew	N/A
Cost Reimbursable CLINS	
CLIN 014 - Estimated Fuel Charges	22.00/DAY
CLIN 015 - Lube Charges per day	3.00/DAY
G&A on ODCs and consumables	Ø
* No G&A on fuel/lubes	

An Employee-Owned Company

Technology Research and Integration Business Unit

DATE: 16 May 2007

TO: Carmen Foreman

FROM: Jim McDonald

SUBJECT: SAIC Subcontract Technical Evaluation Request

VALUE:

Subcontractor Name and Address:
Sea Ventures
PO Box 1202
Fajardo, PR 00738

Project Description: Sea Ventures shall provide charter vessels and crew (as described in their proposal) to support SAIC MTA geophysical survey operations offshore from Vieques and Culebra during the months of June and July, 2007.

You are requested to provide a detailed analysis of the subcontractor's proposal identified below. Please provide **adequate and complete** responses to the questions contained in this memo and any additional information you feel relevant to this effort. Your input will be used in determining the reasonableness and adequacy of the subcontractor's proposal and will allow for the definitization of the subcontract. Since this will accompany the required notice to the Government's Administrative Contracting Officer, your response should be of satisfactory format and content to represent SAIC's expertise in this area.

Overall Proposal Compliance:
Does the proposal meet the technical requirements as defined in the solicitation? If "No", please identify all areas of deficiencies and/or concern that require addressing. This may result in a request for clarification/supplemental information or correction. The proposal meets the technical requirements defined in the SOW.

Material/ODC's: Has the subcontractor proposed any material or associated Other Direct Costs (ODC's) to perform the scoped effort? If "Yes", please provide your assessment of the "need and adequacy" of the proposed types and quantities of material/ODCs proposed as it compares to meeting the requirements of the RFP's Statement of Work. The proposed materials/ODCs fall into three categories. The first have to do with the outfitting/buildout process for the Coral Queen prior to operations. Costs include haul/launch costs and mounting costs for required SAIC components. The second category of materials/ODCs involve fuel/lub/field maintenance costs during charter operations for all three vessels. The third category is provision for overnight security for the Coral Queen and the SAIC components during operations. All proposed costs are appropriate and necessary.

Direct Labor: Has the subcontractor provided a breakdown of proposed labor categories and associated hours? If "Yes", please provide an assessment (by discrete task) on the following areas of your evaluation detailing the proposal content and the reasonableness of it as a part of this offer.

- How does the labor compare between Management/Admin. vs. Technical? Explain how this compares with the scope of work required. As far as I can determine, the labor costs for the Captain and mate are included in the proposed daily charter costs. I do not see any separate call out of per diem costs for either Sea Ventures employee or for labor rates if either the mate or captain is requested to perform dive operations or other duties ancillary to their specified duties with the Coral Queen or M/V explorer. It appears that the mate will provide the overnight security function on the Coral Queen.

  There is also no discussion about Sea Ventures providing labor support during the build-out period on the Coral Queen prior to launch.

  There are no Management/Admin costs proposed. The qualifications and experience of the proposed technical labor support are consistent with the SOW and appropriate for SAIC's requirements to support the operation.

- What is the mix of labor compare for the scope of work as it relates between senior, mid and junior level personnel? Explain how this compares with the scope of work required. The labor mix proposed is appropriate for the requirements in the SOW. The experience and qualifications of the mate are perhaps beyond those that might be required for routine operations, but the mate may be asked to support additional SAIC tasks that might arise during operations. All operations will be carried out at sea and a least one day from access to other support from the mainland. I am happy to have a highly qualified mate available.

- Are there any specific or unique areas of labor required to support the solicited scope of work (i.e. QA, Configuration Mgr. Tech. Writer, etc.)? If "Yes", please elaborate on the requirement and how the proposed labor is sufficient or in-sufficient to meet the requirement. There are obvious experiences, qualifications, and certifications/licenses

required to support charter vessel operations at sea carrying out technical missions. The qualifications of the proposed support employees are appropriate.

Special Tooling/Facilities: Is there any proposed Special Tooling or facilities? If "Yes", detail what the proposed types and quantities of Special Tooling or facilities are and explain how this compares with the requirements of the solicitation? Beyond the special facilities required to support the vessel outfitting and build-out prior to survey operations, no special facilities are required. The necessary support at the marina is available either from Sea Ventures of from the Marina.

Travel: Has the subcontractor proposed Travel? If "Yes", elaborate on the reasonableness of the proposed number of trips, destination(s), duration and number of travelers in moderate detail as it compares the requirements for the subcontractor to adequately perform the solicited SOW. Travel costs are not called out in the Sea Ventures proposal as separable items. Transportation from the main island to Vieques and Culebra are handled as additional charter time.

Schedule: How does the proposed schedule align to support program requirements? The schedule fits the time requirements provided by SAIC.

Summary: Please provide a brief closing summation of your findings of this evaluation and any and recommendations for the basis of negotiations. I think the proposal by Sea Ventures is responsive and complete. It addresses all aspects of the SOW. The only clarification that could be appropriately requested is whether the Captain and Mate's costs are included in the $600/day "Fixed Day Rate Mob/Demob (Dockside) Home Port" quote.

I assume that if SAIC requires additional labor support during the Mob/Demob operations that we will be able to hire them as an out-of-pocket expense paying with cash or credit cards.

VESSEL TIME CHARTERING AGREEMENT

SUBCONTRACT #: 4400145218	**MODIFICATION#: N/A**
DPAS RATING: N/A	**TYPE:** Firm Fixed Price/Fixed Price Day Rate
FIXED PRICE DAY RATE VALUE: $150,000 **TOTAL VALUE: $150,000**	

1. PLACE AND DATE
McLean, Virginia – June 6, 2007

2. OWNER/PLACE OF BUSINESS (FULL ADDRESS INCLUDING TELEPHONE/FAX NUMBER)
Sea Ventures, Inc.
P.O. Box 1202
Fajardo, Puerto Rico 00738
Peter Seufert, Owner TEL (787) 502-1240 FAX (787) 863-0199

3. CHARTERERS/PLACE OF BUSINESS (FULL ADDRESS INCLUDING TELEPHONE/FAX NUMBERS)
Science Applications International Corporation (SAIC)
1710 SAIC Drive
M/S T2-4-2
McLean, VA 22102
Carmen Foreman TEL (703) 676-5043 FAX (703) 676-2925

4. VESSEL'S NAME
M/V Coral Queen
M/V Explorer
Carolina Skiff

5. DATE OF DELIVERY
On or about July 16, 2007

6. CANCELING DATE N/A

7. PORT OF PLACE OF DELIVERY
Mooring points in the Bahia Salinas del Sur – Fajardo, PR

8. (I) PORT OF PLACE OF REDELIVERY: Islands of Vieques and Culebra, Puerto Rico
(II) NO. DAYS NOTICE OF REDELIVERY: 10 days

9. PERIOD OF HIRE
June 6, 2007 – July 16, 2008

10. (I) EXTENSION OF PERIOD OF HIRE: 60 days
(II) NO. DAYS ADVANCE NOTICE: 5 days

11. AUTOMATIC EXTENSION PERIOD TO COMPLETE VOYAGE
(I) VOYAGE OR WELL – N/A
(II) MAX EXTENSION PERIOD – N/A

12. MOBILIZATION CHARGE
Fixed Daily Rate: See Section 1.0 of the Agreement

13. PORT AND PLACE OF MOBILIZATION
Islands of Vieques and Culebra, Puerto Rico

14. EARLY TERMINATION OF CHARTER (STATE AMOUNT OF HIRE PAYABLE) – See Section 25.0 of Agreement

15. DEMOBILIZATION CHARGE (LUMP SUM) – See Section 1.0 of Agreement

16. AREA OF OPERATION – Islands of Vieques and Culebra, Puerto Rico

17. EMPLOYMENT OF VESSEL RESTRICTED TO (STATE NATURE OF SERVICES) – Survey support – ferry/towing vessels

18. CHARTER HIRE (STATE RATE AND CURRENCY) – See Section 1.0 of Agreement

19. EXTENSION HIRE (IF AGREED, STATE RATE) – Not Applicable

20. INVOICING FOR HIRE AND OTHER PAYMENTS

(i) STATE WHETHER TO BE ISSUED IN ADVANCE OR ARREARS - Arrears

(ii) STATE TO WHOM TO BE ISSUED IF OTHER THAN OWNER

(iii)STATE TO WHOM TO BE ISSUED IF OTHER THAN CHARTERER

21. PAYMENTS (STATE MODE AND PLACE OF PAYMENT, ALSO STATE BENEFICIARY AND BANK ACCOUNT) – Payments will be made via Automated Clearing House (ACH) Transfer Authorization (form on file) to Banco Popular – Fajardo Branch

22. PAYMENT OF HIRE, BUNKER INVOICES AND DISBURSEMENTS FOR CHARTERERS ACCOUNT (STATE MAXIMUM NUMBER OF DAYS) – Invoices for Bunker and other cost reimbursable items to be submitted on a monthly basis; Payment terms Net 45 from the date of invoice receipt

23. MEALS (STATE RATE AGREED)
See Section 1.0 of Agreement

24. ACCOMMODATION (STATE RATE AGREED) – See Section 1.0 of the Agreement

25. BREAKDOWN (STATE PERIOD AND PROVISION) - See Section 14.0 of Agreement

26. NAMES AND ADDRESSES FOR NOTICES AND OTHER COMMUNICATIONS REQUIRED TO BE GIVEN BY THE OWNERS - See Charter's information, Box 3

27. NAMES AND ADDRESS FOR NOTICES AND OTHER COMMUNICATIONS REQUIRED TO BE GIVEN BY THE CHARTERERS – See Owner's information Box 2

INTRODUCTION

This Vessel Time Chartering Agreement, effective June 6, 2007 is made between SCIENCE APPLICATIONS INTERNATIONAL CORPORATION (hereinafter known as "Charterer"), a Delaware corporation with principal offices in San Diego, California, and Sea Ventures, Inc.(hereinafter known as "Owners"), a corporation, with principal offices in (city) Fajardo, Puerto Rico. The effort to be performed by Owners under this Subcontract will be part of Charterer's Prime Contract DACA72-03-C-0016 that has been issued by the Army Corps of Engineers. The work, defined in Attachment 1 (Statement of Work) will be performed on a Firm Fixed-Price for Subcontract Line Item Numbers (SLINS) (Numbers will be provided upon definitization of subcontract) and SLINS (Numbers will be provided upon definitization of subcontract) will be on a Fixed

Price Day Rate basis, in accordance with Terms and Conditions stated herein, and any referenced documents listed in section 35.0 Order Of Precedence clause of this agreement.

1.0 PRICE

The fixed price day rates for the vessel in Box 4 are as follows:

Fixed Price CLINS	**M/V Coral Queen**
CLIN 001 Fixed Day Rate Mob/Demob (Dockside) Home Port	$ 600
CLIN 002 Fixed Day Rate Mob/Demob (Dockside at other than Home Port)	$ 850
CLIN 003-Fixed Price Vessel Haul/Re-launch for Transducer Installation	$ 1,650
CLIN 004- Fixed Price Vessel Haul/Re-launch -Transd/Underhull Mount Removal	$ 1,650
CLIN 005-Fixed Price -Underhull Transducer Mod Install	$ 550
CLIN 006-Fixed Price Underhull Transducer Mount Removal/Hull Restoration	$ 250
CLIN 007-Fixed Day Rate during Vessel Haul and Re-launch Period	$ 100
CLIN 008-Fixed Day Rate for Operational Day (at sea)	$ 1,850
CLIN 009- Fixed Day Rate for in Port Stand-by	$ 600
CLIN 010-Fixed Day Rate Long Term Shutdown-Vessel Home Port	$ 150
CLIN 011-Fixed Day Rate Long Term Shutdown at other Port	$ 275
CLIN 012-Rate pp Meals & Accommodations for Scientific Crew	$ 100
Security Guard	$ 150
Cost Reimbursable CLINS	
CLIN 014 - Estimated Fuel Charges	$ 160
CLIN 015 - Lube Charges per day	$ 5
G&A on ODCs and consumables	N/A

Fixed Price CLINS	**M/V Explorer**
CLIN 001 Fixed Day Rate Mob/Demob (Dockside) Home Port	$ -
CLIN 002 Fixed Day Rate Mob/Demob (Dockside at other than Home Port)	$ -
CLIN 003-Fixed Price Vessel Haul/Re-launch for Transducer Installation	$ -
CLIN 004- Fixed Price Vessel Haul/Re-launch -Transd/Underhull Mount Removal	$ -
CLIN 005-Fixed Price -Underhull Transducer Mod Install	$ -
CLIN 006-Fixed Price Underhull Transducer Mount Removal/Hull Restoration	$ -
CLIN 007-Fixed Day Rate during Vessel Haul and Re-launch Period	$ -
CLIN 008-Fixed Day Rate for Operational Day (at sea)	$ 750
CLIN 009- Fixed Day Rate for in Port Stand-by	$ 75
CLIN 010-Fixed Day Rate Long Term Shutdown-Vessel Home Port	$ -
CLIN 011-Fixed Day Rate Long Term Shutdown at other Port	$ -
CLIN 012-Rate pp Meals & Accommodations for Scientific Crew	$ -
Cost Reimbursable CLINS	
CLIN 014 - Estimated Fuel Charges	$ 30
CLIN 015 - Lube Charges per day	$ 5
G&A on ODCs and consumables	0%
* No G&A on fuel/lubes	

Fixed Price CLINS	Carolina Skiff
CLIN 001 Fixed Day Rate Mob/Demob (Dockside) Home Port	$ -
CLIN 002 Fixed Day Rate Mob/Demob (Dockside at other than Home Port)	$ -
CLIN 003-Fixed Price Vessel Haul/Re-launch for Transducer Installation	$ -
CLIN 004- Fixed Price Vessel Haul/Re-launch -Transd/Underhull Mount Removal	$ -
CLIN 005-Fixed Price -Underhull Transducer Mod Install	$ -
CLIN 006-Fixed Price Underhull Transducer Mount Removal/Hull Restoration	$ -
CLIN 007-Fixed Day Rate during Vessel Haul and Re-launch Period	$ -
CLIN 008-Fixed Day Rate for Operational Day (at sea)	$ 350
CLIN 009- Fixed Day Rate for in Port Stand-by	$ 25
CLIN 010-Fixed Day Rate Long Term Shutdown-Vessel Home Port	$ -
CLIN 011-Fixed Day Rate Long Term Shutdown at other Port	$ -
CLIN 012-Rate pp Meals & Accommodations for Scientific Crew	$ -
Cost Reimbursable CLINS	
CLIN 014 - Estimated Fuel Charges	$ 22
CLIN 015 - Lube Charges per day	$ 3
G&A on ODCs and consumables	0%
* No G&A on fuel/lubes	

**** Notes for Cost Reimbursable CLINS:**

1. This is a lump sum cost for vessel mobilization prior to dry dock, including cost for removal of stern winches and knuckle boon crane, excess insurance coverage, installation of hydraulic “A” Frame, delivery of vessel to place of dry dock and redelivery of vessel from place of dry dock to port of mobilization. It also includes removal of “A” Frame and reinstallation of crane and winches, as well as grinding welds, painting and restoration of decks to pre-charter condition at project completion. This work is to be completed prior to delivery and after re-delivery, incurring no day rate charges.
2. This figure represents estimated fuel consumption rates at an average operational speed of 8-10 kts. Actual fuel usage will vary. Fuel cost will be invoiced periodically at actual replacement cost, with no additional mark-up or additions.

1.1 PERIOD

(a) The Owners stated in Box 2 and the Charterers stated in Box 3 hire the Vessel named in Box 4, as specified in ANNEX “A” (hereinafter referred to as “the Vessel”), for the period as stated in Box 9 from the time the Vessel is delivered to the Charterers.

(b) Subject to Clause 18(b), the Charterers have the option to extend the Charter Period in direct continuation for the period stated in Box 10(i), but such an option must be declared in accordance with Box 10 (ii).

(c) The Charter Period shall automatically be extended for the time required to complete the voyage or well (whichever is stated in Box 11(i)), in progress, such time not to exceed the period stated in Box 11(ii)).

1.2 DELIVERY AND REDELIVERY

(a) <u>Delivery</u> – Subject to sub-clause (b) of this Clause the Vessel shall be delivered by the Owners free of cargo and with clean tanks at any time between the date stated in Box 5 and the date stated in Box 6 at the port or place stated in Box 7 where the Vessel can safely lie always afloat.

(b) Mobilization – (i) The Charterers shall pay a lump sum as stated in Box 12 without discount by way of mobilization charge in consideration of the Owners giving delivery at the port or place stated in Box 7. The mobilization charge shall not be affected by any change in the port or place of mobilization from that stated in Box 13.

(ii) Should the Owners agree to the Vessel loading and transporting cargo and/or undertaking any other service for the Charterers en route to the port of delivery or from port of redelivery then all terms and conditions of this Charter Party shall apply to such loading and transporting and/or other service exactly as if performed during the Charter Period excepting only that any lump sum freight agreed in respect thereof shall be payable on shipment or commencement of the service as the case may be, the Vessel and/or goods lost or not lost.

(c) Canceling – If the Vessel is not delivered by midnight local time on the canceling date stated in Box 6, the Charterers shall be entitled to cancel this Charter Party. However if despite the exercise of due diligence by the Owners, the Owners will be unable to deliver the Vessel by the canceling date, they may give notice in writing to the Charterers at any time prior to the delivery date as stated in Box 5 and shall state in such notice the date by which they will be able to deliver the Vessel. The Charterers may within 24 hours of receipt of such notice give notice in writing to the Owners canceling this Charter Party. If the Charterers do not give such notice, then the later date specified in the Owners' notice shall be substituted for the canceling date for all purposes of this Charter Party. In the event the Charterers cancel the Charter Party, it shall terminate on terms that neither party shall be liable to the other for any losses incurred by reason of the non-delivery of the Vessel or the cancellation of the Charter Party.

(d) Redelivery – The Vessel shall be redelivered on the expiration or earlier termination of this Charter Party free of cargo and with clean tanks at the port or place as stated in Box 8(i) or such other port or place as may be mutually agreed. The Charterers shall give not less than the number of days notice in writing of their intention to redeliver the Vessel, as stated in Box 8(ii).

(e) Demobilization – The Charterers shall pay a lump sum without discount in the amount as stated in Box 15 by way of demobilization charge which amount shall be paid on the expiration or on earlier termination of this Charter Party.

1.3 CONDITION OF VESSEL

(a) The Owners undertake that at the date of delivery under this Charter Party the Vessel shall be of the description and classification as specified in ANNEX "A", attached hereto, and undertake to so maintain the Vessel during the period of service under this Charter Party.

(b) The Owners shall before and at the date of delivery of the Vessel and throughout the Charter Period exercise due diligence to make and maintain the Vessel tight, staunch, strong in good order and condition and, without prejudice to the generality of the foregoing, in every way fit to operate effectively at all times for the services as stated in 14.0 Suspension Of Hire.

1.4 INVOICES

Invoices shall be prepared in duplicate and contain the following information; subcontract number, subproject number, item number, description of articles, sizes, quantities, unit prices and extended totals. Invoices will be submitted electronically to: **saic-ap-subk-wflow@saic.com**.

Invoices shall clearly reference a unique invoice number on each invoice, and the date of the invoice. Invoices shall include the "Amount Previously Billed," the "Amount of this Invoice," and the "Total Amount Billed to Date."

All invoices shall be issued in the contract currency stated in Box 18. In respect of reimbursable expenses incurred in currencies other than the contract currency, the rate of exchange into the contract currency shall be that quoted by the Central Bank of the country of such other currency as at the date of the Owners' invoice. Invoices covering Hire and any other payments due shall be issued monthly as stated in Box 20(i) or at the expiration or earlier termination of this Charter Party. Notwithstanding the foregoing, bunkers and lubricants on board at delivery shall be invoiced at the time of delivery.

1.5 PAYMENT

Payment terms will be Net 15 days and paid within fifteen (15) days after receipt of a proper invoice or acceptance of delivered items or services rendered by the Charterer, which ever occurs later, unless otherwise specified in this subcontract. Charterer may make any adjustments in Owners' invoices due to shortages, late delivery, or other failure to comply with the requirements of this subcontract before payment. Cash discounts will be taken from date of acceptance of delivered items or date of acceptable invoice, whichever is later. Payment shall not constitute final acceptance. Charterer may offset against any payment hereunder any amount owed to Charterer by Owners.

However any advances for disbursements made on behalf of and approved by the Owners may be deducted from Hire due.

Note: "Seller may select Automated Clearing House Credits ("ACH funds transfer"), as the means of settlement. With regard to such ACH funds transfer, a payment from Buyer to Seller shall be considered timely with respect to any payment due date contained herein if the ACH funds transfer is completed no later than four (4) business days after such payment due date. Buyer shall not be in breach of these terms and conditions, or suffer any loss of discount or other penalty, with respect to an ACH funds transfer that was initiated properly and timely by Buyer to the extent its completion is delayed because of failure or delay by the ACH funds transfer system, the operation of an ACH funds transfer system rule which could not be anticipated by Buyer, or rejection by the Seller's bank."

1.6 AUDIT

The Charter shall have the right to appoint an independent chartered accountant to audit the Owners books directly related to work performed under this Charter Party at any time after the conclusion of the Charter Party to determine validity of the Owners' charges hereunder. The Owners undertake to make their records available for such purposes at their principal place of business during normal working hours. Any discrepancies discovered in payments shall be promptly resolved by invoice or credit as appropriate.

2.0 TECHNICAL AND CONTRACTUAL REPRESENTATIVES

The following authorized representatives are hereby designated for this Subcontract:

Owners:	Charterer:
Technical: Peter Seufert	Technical: Jim McDonald
Contractual: Peter Seufert	Contractual: Carmen Foreman

2.1 CONTACTS

Contacts with the Charter that affect the subcontract prices, schedule, statement of work, and subcontract terms and conditions shall be made with the authorized contractual representative. No changes to this Subcontract shall be binding upon Charterer unless incorporated in a written modification to the Subcontract and signed by Charterer's contractual representative.

2.2 CHANGES

Charter may, by written notice to Owners at any time before complete delivery is made under this subcontract, make changes within the general scope of this subcontract including but not limited to any one of the following: (a) quantity; (b) delivery; and (d) make changes in the amount of Charterer furnished property. If any such change causes a material increase or decrease in the cost of, or the time required for the performance of any part of the work under this subcontract, the Charterer shall make an equitable adjustment in the subcontract price or delivery schedule, or both, and shall modify the subcontract. As a condition precedent to any equitable adjustment, the Owners must notify Charterer in writing of any request for adjustment within twenty (20) days from the date Owners receive notice from Charterer of a change, or from the date of any act of Charterer that Owners considers to constitute a change. Failure to agree to any adjustment shall be a dispute under the Disputes clause of this subcontract. However, Owners shall proceed with the work as changed without interruption and without awaiting settlement of any such claim.

3.0 DISCLOSURE

Owners shall not disclose information concerning work under this Subcontract to any third party, unless such disclosure is necessary for the performance of the subcontract effort. No news releases, public announcement, denial or confirmation of any part of the subject matter of this Subcontract or any phase of any program hereunder shall be made without prior written consent of Charterer. The restrictions of this paragraph shall continue in effect upon completion or termination of this Subcontract for such period of time as may be mutually agreed upon in writing by the parties. In the absence of a written established period, no disclosure is authorized. Failure to comply with the provisions of this Clause may be cause for termination of this subcontract.

4.0 ASSIGNMENTS AND SUBCONTRACTS

This Subcontract is not assignable and shall not be assigned by Owners without the prior written consent of Charterer. Further, Owner agrees to obtain Charterer's approval before subcontracting this order or any substantial portion thereof; provided, however, that this limitation shall not apply to the purchase of standard commercial supplies or raw materials.

5.0 INSURANCE

The Owners shall procure and maintain in effect for the duration of this Charter Party, with reputable insurers, the insurances set forth below. Policy limits shall not be less than those indicated. Reasonable deductibles are acceptable and shall be for the account of the Owners. The Charterers shall be named as additional insured. The Owners shall cause insurers to waive subrogation rights against the Charterers as encompassed in Clause 20(b)(i). Additional insurance and/or waivers of subrogation shall be given only insofar as these relate to liabilities that are properly the responsibility of the Owner under the terms of this Charter Party.

The Owners shall furnish the Charterers with certificates of insurance, which provide sufficient information to verify that the Owners have complied with the insurance requirements of this Charter Party.

If the Owners fail to comply with the aforesaid insurance requirements, the Charterers may, without prejudice to any other rights or remedies under this Charter Party, purchase similar coverage and deduct the cost there from any payment due to the Owners under this Charter Party.

Special Provisions Applicable to Owners's Insurance coverage:

1. Additional Insured - Owners shall have all policies, except Workers' Compensation, endorsed to name Charterer as an Additional Insured with respect to the work to be performed by the Owners.
2. Waiver of Subrogation - Owners shall have all policies endorsed to waive the insurer's rights of subrogation in favor of Charterer.
3. Deductibles - Subject to the reasonable review and approval of Charterer, the Owners may arrange deductibles or self-insured retention's as part of the required

insurance coverage's. However, it is expressly agreed that all deductibles or self-insured retention's are the sole responsibility of the Owners.

4. Adequacy of Insurance Limits - The insurance coverage limits stated below are minimum coverage requirements, not limits of liability, and shall not be construed in any way as Charterer's acceptance of responsibility of the Owners.
5. Certificates of Insurance - Prior to commencement of any work under this Agreement, the Owners shall furnish Charterer with Certificates of Insurance, in a format acceptable to Charterer, evidencing the insurance coverage required in this Agreement and containing the following information:
   a. Identify Charterer as an "Additional Insured" with respect to all policies except Workers' Compensation and employers' liability.
   b. State that all policies have been endorsed to waive subrogation in favor of Charterer.
   c. State that the underwriters agree to provide Charterer with at least 30 days prior written notice of any cancellation or material change in the coverage.

Insurance Policies (as applicable) to be procured and maintained by the Owners under this Clause:

Marine Hull Insurance – Hull and Machinery Insurance shall be provided with limits equal to those normally carried by the Owners for the Vessel.

Protection and Indemnity (Marine Liability) Insurance – Protection and Indemnity or Marine Liability insurance shall be provided for the Vessel with a limit equal to the value of U. S. $5,000,000, and shall include but not be limited to coverage for crew liability, third party bodily injury and property damage liability, including collision liability, towers liability (unless carried elsewhere)

General Third Party Liability Insurance – Coverage shall be for:

Bodily Injury - $1,000,000 per person

Property Damage - $1,000,000 per occurrence

General Aggregate - $2,000,000

Workmen's Compensation and Employer's Liability Insurance for Employees (including USL&H coverage in the U.S.) – Covering employees for statutory benefits as set out and required by local law in area of operation or area in which the Owners may become legally obligated to pay benefits. Employers Liability - $1,000,000

Comprehensive Automobile Liability Insurance – Covering all owned, hired and non-owned vehicles, coverage shall be for at least statutory limits set by local law.

Contractor Pollution Liability - Covering sudden and non-sudden release of pollutants resulting in damage to the environment or in bodily injury arising out of the operations or services of Owners. Minimum per occurrence limits of liability of $5,000,000.

6.0 INDEMNIFICATION

(a) Seller shall indemnify, defend and hold SAIC and SAIC's customers harmless from and against any and all damages, losses, liabilities and expenses (including reasonable attorneys' fees) arising out of or relating to any claims, causes of action,

lawsuits or other proceedings, regardless of legal theory, that result, in whole or in part, from Seller's (or any of Seller's subcontractors, suppliers, employees, agents or representatives): (i) intentional misconduct, negligence, or fraud, (ii) breach of any representation, warranty or covenant made herein, or (iii) products or services including, without limitation, any claims that such products or services infringe any United States patent, copyright, trademark, trade secret or any other proprietary right of any third party.

(b) Buyer shall promptly notify Seller of any claim against Buyer that is covered by this indemnification provision and shall authorize representatives of Seller to settle or defend any such claim or suit and to represent Buyer in, or to take charge of, any litigation in connection therewith.

7.0 DISPUTES

Any dispute shall be disposed in the following manner.

(a) Charterer and Owners agree to enter into Negotiation to resolve any dispute. Both parties agree to negotiate in good faith to reach a mutually agreeable settlement within a reasonable amount of time.

(b) If negotiations are unsuccessful, Charterer and Owners agree to enter into binding Arbitration. The American Arbitration Association (AAA) Commercial Arbitration Rules (most recent edition) are to govern this Arbitration. The Arbitration shall take place in the County of San Diego, State of California. The Arbitrator shall be bound to follow the applicable subcontract provisions and California law in adjudicating the dispute. It is agreed by both parties that the Arbitrator's decision is final and binding. The judgment rendered by the Arbitrator may be entered in any court having jurisdiction thereof.

Pending any decision, appeal or judgment referred to in this provision or the settlement of any dispute arising under this Subcontract, Owners shall proceed diligently with the performance of this Subcontract.

8.0 EMPLOYMENT AND AREA OF OPERATION

(a) The Vessel shall be employed in offshore activities, which are lawful in accordance with the law of the place of the Vessel's flag, and/or registration and of the place of operation. Such activities shall be restricted to the service(s) as stated in Box 17, and to voyages between any good and safe port or place and any place or offshore unit where the Vessel can safely lie always afloat within the Area of Operation as stated in Box 16 which shall always be within Institute Warranty Limits and which shall in no circumstances be exceeded without prior agreement and adjustment of the Hire and in accordance with such other terms as appropriate to be agreed; provided always that the Charterers do not warrant the safety of any such port or place or offshore unit but shall exercise due diligence in issuing their orders to the Vessel as if the Vessel were their own property and having regard to her capabilities and the nature of her employment. Vessel may be used as a diving platform.

(b) The Charterer's shall obtain relevant permission and licenses from responsible authorities for the Vessel to enter, work in and leave the Area of Operation and the Owners shall assist, if necessary, in every way possible to secure such permission and licenses.

(c) The Vessel's Space – The whole reach and burden and decks of the Vessel shall throughout the Charter Period be at the Charterers' disposal reserving proper and sufficient space for the Vessel's Master, Officers, Crew, tackle, apparel, furniture, provisions and stores. The Charterers shall be entitled to carry, so far as space is available, and for their purposes in connection with their operations:

(i) Persons other than crew members, other than fare paying, and for such purposes to make use of the Vessel's available accommodation not being used on the voyage by the Vessel's Crew. The Owners shall provide suitable provisions and requisites for such persons for which the Charterers shall pay at the rate as stated in Box 23 per meal and at the rate as stated in Box 24 per day for the provision of bidding and services for persons using berth accommodation.

(ii) Lawful cargo whether carried on or under deck.

(iii) Hazardous and noxious substances subject to Clause 20 (c), proper notification and any pertinent regulations.

(d) Laying-up of Vessel – The Charterers shall have the option of laying up the Vessel at an agreed safe port or place for all or any portion of the Charter Period in which case the Hire hereunder shall continue to be paid but, if the period of such lay-up exceeds 30 consecutive days there shall be credited against such Hire the amount which the Owners shall reasonably have saved by way of reduction in expenses and overheads as a result of the lay-up of the Vessel.

9.0 MASTER AND CREW

(a) The Master shall carry out his duties promptly and the Vessel shall render all reasonable services within her capabilities by day and by night and at such times and on such schedules as the Charterers may reasonably require without any obligations of the Charterers to pay to the Owners or the Master, Officers or the Crew of the Vessel any excess or overtime payments. The Charterers shall furnish the Master with all instructions and sailing directions and the Master and Engineer shall keep full and correct logs accessible to the Charterers or their agents.

(b) The Vessel's Crew if required by Charterers will connect and disconnect electric cables, fuel, water and pneumatic hoses when placed on board the Vessel in port as well as alongside the offshore units; will operate the machinery on board the Vessel for leading the unloading cargoes; and will hook and unhook cargo on board the Vessel when loading or discharging alongside offshore units. If the port regulations or the Seamen and/or labor unions do not permit the Crew of the Vessel to carry out any of this work, then the Charterers shall make, at their own expense, whatever other arrangements may be necessary always under the direction of the Master.

(c) If the Charterers have reason to be dissatisfied with the conduct of the Master or any Officer or member of the Crew, the Owners on receiving particulars of the complaint shall promptly investigate the matter and if the complaint proves to be well founded, the Owners shall as soon as reasonably possible make appropriate changes in the appointment.

(d) The entire operation, navigation, and management of the Vessel shall be in the exclusive control and command of the Owners, their Master, Officers and rendered as requested by the Charterers, subject always to the exclusive right of the Owners or the Master of the Vessel to determine whether operation of the Vessel may be safely undertaken. In the performance of the Charter Party, the Owners are deemed to be an independent contractor, the Charterers being concerned only with the results of the services performed.

10.0 OWNERS TO PROVIDE

(a) The Owners shall provide and pay for all provisions, wages and all other expenses of the Master, Officers and Crew; all maintenance and repair of the Vessel's hull, machinery and equipment as specified in ANNEX "A"; also, except as otherwise provided in this Charter Party, for all insurance on the Vessel, all dues and charges directly related to the Vessel's flag and/or registration, all deck, cabin and engine room stores, cordage required for ordinary ship's purposes mooring alongside in harbor, and all fumigation expenses and pest control certificates. The Owners' obligations under this Clause extend to cover all liabilities for consular charges appertaining to the Master, Officers and Crew, customs or import duties arising at any time during the performance of this Charter Party in relation to the stores, provisions and other matters as aforesaid which the Owners are to provide and/or pay for and the Owners shall refund to the Charter any sums they or their agents may have paid or been compelled to pay in respect of such liability.

(b) On delivery the Vessel shall be equipped, if appropriate, at the Owners' expense with any towing and anchor handling equipment specified in Section 5(b) of ANNEX "A: If during the Charter Period any such equipment becomes lost, damaged or unserviceable, as a result of the Charterers negligence, the Charterer shall either provide, or direct the Owners to provide, an equivalent replacement at the Charterers expense.

11.0 CHARTERER TO PROVIDE

(a) While the Vessel is on hire the Charterers shall provide and pay for all fuel, lubricants, water, dispersants, firefighting foam and transport thereof, port charges, pilotage and boatmen and canal steersmen (whether compulsory or not), launch hire (unless incurred in connection with the Owners' business) light dues, tug assistance, canal dock, harbor, tonnage and other dues and costs for security or other watchmen and of quarantine (if occasioned by the nature of the cargo carried or the ports visited whilst employed under this Charter Party but not otherwise).

(b) At all times the Charterers shall provide and pay for the loading and unloading of cargoes so far as not done by the Vessel's crew, cleaning of cargo tanks, all

necessary dunnage, uprights and shoring equipment for securing deck cargo, all cordage except as to be provided by the Owners, all ropes slings and special runners (including bulk cargo discharge hoses) actually used for loading and discharging, inert gas required for the protection of cargo, and electrodes used for offshore works, and shall reimburse the Owners for the actual cost of replacement of special mooring lines to offshore units, wires, nylon spring lines etc. used for offshore works, all hose connections and adapters, and further, shall refill oxygen/acetylene bottles used for offshore works.

(c) The Charterers shall pay for customs duties, all permits, import duties (including costs involved in establishing temporary or permanent importation bonds), and clearance expenses, both for the Vessel and/or equipment, required for or arising out of this Charter Party.

12.0 BUNKERS

Unless otherwise agreed, the Vessel shall be delivered with bunkers and lubricants as on board and redelivered with sufficient bunkers to reach the next bunkering stage en route to her next port of call. The Charterers upon delivery and the Owners upon redelivery shall take over and pay for the bunkers and lubricants on board at the prices prevailing at the times and ports of delivery and redelivery.

13.0 HIRE

(a) Hire – The Charterers shall pay Hire for the Vessel at the rate stated in Box 18 per day or pro rata for part thereof from the time that the Vessel is delivered to the Charterers until the expiration or earlier termination of this Charter Party.

(b) Extension Hire – If the option to extend the Charter Period under Clause 1.1(b) is exercised, Hire for such extension shall, unless stated in Box 19, be mutually agreed between the Owners and the Charterers.

(c) Adjustment of Hire – The rate of hire shall be adjusted to reflect documented changes after the date of entering into the Charter Party or the date of commencement of employment, whichever is earlier in the Owners' costs arising from changes in the Charterers' requirements or regulations governing the Vessel and/or its Crew or this Charter Party.

14.0 SUSPENSION OF HIRE

(a) If as a result of any deficiency of Crew or of the Owners' stores, strike of Master, Officers and Crew, breakdown of machinery, damage to hull or other accidents to the Vessel, the Vessel is prevented from working, no Hire shall be payable in respect of any time lost and any Hire paid in advance shall be adjusted accordingly provided always however that Hire shall not cease in the event of the Vessel being prevented from working as aforesaid as a result of:

(i) the carriage of cargo as noted in Clause 13(c)(iii),

(ii) quarantine or risk of quarantine unless caused by the Master, Officers or Crew having communications with the shore at any infected area not in connection with the employment of the Vessel without the consent or the instructions of the Charterers;

(iii) deviation from her Charter Party duties or exposure to abnormal risks at the request of the Charterers;

(iv) detention in consequence of being driven into port or to anchorage through stress of weather or trading to shallow harbors or to river or ports with bars or suffering an accident to her cargo, when the expenses resulting from such detention shall be for the Charterers' account howsoever incurred;

(v) detention or damage by ice;

(vi) any act or omission of the Charterers, their servants or agents.

(b) Maintenance and Dry-docking – Notwithstanding sub-clause (a) hereof, the Charterers shall grant the Owners a maximum of 24 hours on hire, which shall be cumulative, per month or pro rata for part of a month from the commencement of the Charter Period for maintenance and repairs including dry-docking (hereinafter referred to as "maintenance allowance"). The Vessel shall be dry-docked at regular intervals. The Charterers shall place the Vessel at the Owners' disposal clean of cargo, at a port (to be nominated) by the Owners at a later date) having facilities suitable to the Owners for the purpose of such dry-docking. During reasonable voyage time taken in transits between such port and Area of Operation the Vessel shall be on hire and such time shall not be counted against the accumulated maintenance allowance. Hire shall be suspended during any time taken in maintenance repairs and dry-docking in excess of the accumulated maintenance allowance. In the event of less time being taken by the Owners for repairs and dry-docking or, alternatively, the Charterers not making the Vessel available for all or part of this time, the Charterers shall, upon expiration or earlier termination of the Charter Party, pay the equivalent of the daily rate of Hire then prevailing in addition to Hire otherwise due under this Charter Party in respect of all such time not so taken or made available.

Upon commencement of the Charter Period, the Owners agree to furnish the Charterers with the Owners' proposed dry-docking schedule and the Charterers agree to make every reasonable effort to assist the Owners adhering to such predetermined dry-docking schedule for the Vessel.

15.0 LIABILITIES

(a) Limitations – Nothing contained in this Charter Party shall be construed or held to deprive the Owners or the Charterers as against any person or party including as against each other, of any right to claim limitation of liability provided by any applicable law, statute or convention, save that nothing in this Charter Party shall create any right to limit liability, with the exception of subparagraph (b) hereof. Where the Owners or the Charterers may seek an indemnity under the provisions of this Charter Party or against each other in respect of a claim brought by a third party, the Owners or the Charterers shall seek to limit their liability against such third party.

(b) Himalaya Clause

(i) All exceptions, exemptions, defenses, immunities, limitations of liability, indemnities, privileges and conditions granted or provided by this Charter Party or by any applicable statute, rule or regulation for the benefit of the Charterers shall also apply to and be for the benefit of the Charterers' parent, affiliated,

related and subsidiary companies; the Charterers' contractors, sub-contractors, joint venturers and joint venture interest owners (always with respect to the job or project on which the Vessel is employed); their respective employees and their respective underwriters.

(ii) All exceptions, exemptions, defenses, immunities, limitations of liability, indemnities, privileges and conditions granted or provided by this Charter Party or by any applicable statute, rule or regulation for the benefit of the Owners shall also apply to and be for the benefit of the Owners' parent, affiliated, related and subsidiary companies, the Owners' sub-contractors, the Vessel, its Master, Officers and Crew, its registered owner, its operator, its demise charterer(s), their respective employees and their respective underwriters.

(iii) The Owners or the Charterers shall be deemed to be acting as agent or trustee of and for the benefit of all such persons and parties set forth above, but only for the limited purpose of contracting for the extension of such benefits to such persons and parties.

16.0 POLLUTION

Except as otherwise provided for in Clause 17(c), the Owners shall be liable for, and agree to indemnify, defend and hold the Charterers harmless against, all claims, costs, expenses, actions, proceedings, suits, demands and liabilities whatsoever arising out of actual or potential pollution damage and the cost of cleanup or control thereof arising from acts or omissions of the Owners or their personnel which cause or allow discharge, spills or leaks from the Vessel, except as may emanate from cargo thereon or therein.

17.0 SAVING OF LIFE AND SALVAGE

(a) The Vessel shall be permitted to deviate for the purpose of saving life at sea without prior approval of or notice to the Charterers and without loss of Hire provided however that notice of such deviation is given as soon as possible.

(b) Subject to the Charterers' consent, which shall not be unreasonably withheld, the Vessel shall be at liberty to undertake attempts at salvage, it being understood that the Vessel shall be off hire from the time she leaves port or commences to deviate and shall remain off-hire until she is again in every way ready to resume the Charterers' service at a position which is not less favorable to the Charterers than the position at the time of leaving port or deviating for the salvage services.

All salvage monies earned by the Vessel shall be divided equally between the Owners and the Charterers, after deducting the Master's, Officers' and Crew's share, legal expenses, value of fuel and lubricants consumed, Hire of the Vessel lost by the Owners during the salvage, repairs to damage sustained, if any, and any other extraordinary loss or expense sustained as a result of the salvage.

The Charterers shall be bound by all measures taken by the Owners in order to secure payment of salvage and to fix its amount.

(c) The Owners shall waive their right to claim any award for salvage performed on property owned by or contracted to the Charterers, always provided such property was the object of the operation the Vessel was chartered for, and the Vessel shall remain on hire when rendering salvage services to such property. This waiver is without prejudice to any rights the Vessel, Master, Officers and Crew may have under any title.

18.0 LIEN
The Charterers shall have a lien on the Vessel for all monies paid in advance and not earned.

19.0 SUBSTITUTE VESSEL
The Owners shall be entitled at any time, whether before delivery or at any other time during the Charter Period, without undue inconvenience or expense to the Charterer, provide a substitute vessel, subject to the Charterers' prior approval, which shall not be unreasonably withheld.

20.0 WAR
The Vessel shall not be ordered nor continue to any port or place or on any voyage nor be used on any service which will bring the Vessel within a zone which is dangerous as a result of any actual or threatened act of war, war, hostilities, warlike operations, acts of piracy or of hostility or malicious damage against this or any other vessel or its cargo by any person, body or state whatsoever.

21.0 GENERAL AVERAGE AND NEW JASON CLAUSE
General Average shall be adjusted and settled in London unless otherwise stated in this agreement, according to York/Antwerp Rules, 1974, as may be amended. Hire shall not contribute to General Average. Should adjustment be made in accordance with the law and practice of the United States of America, the following provision shall apply:

> "In the event of accident, danger, damage or disaster before or after the commencement of the voyage, resulting from any cause whatsoever, whether due to negligence or not, for which, or for the consequence of which the Owners are not responsible, by statute, contract or otherwise, the cargo, shippers, consignees or owners of the cargo shall contribute with the Owners in General Average to the payment of any sacrifices, loss or expenses of a General Average nature that may be made or incurred and shall pay salvage and special charges incurred in respect of the cargo. If a salving vessel is owned or operated by the Owners, salvage shall be paid for as fully as if the said salving vessel or vessels belonged to strangers. Such deposit as the Owners, or their agents, may deem sufficient to cover the estimated contribution of the cargo and any salvage and special charges thereon shall, if required, be made by the cargo, shippers, consignees or owners of the cargo to the Owners before delivery".

22.0 STRUCTURAL ALTERATIONS AND ADDITIONAL EQUIPMENT.
The Charterers shall have the option of, at their expense, making structural alterations to the Vessel or installing additional equipment with the written consent of the Owners, which shall not be unreasonably withheld, but unless otherwise agreed the Vessel is to be redelivered reinstated, at the Charterers' expense to her original condition. The Vessel is to remain on hire during any period of these alterations or reinstatement. The Charterers, unless otherwise agreed, shall be responsible for repair and maintenance of any such alteration or additional equipment.

23.0 HEALTH AND SAFETY
The Owners shall comply with and adhere to all applicable international, national and local regulations pertaining to health and safety, and such Charterers' instructions as may be appended hereto.

24.0 TAXES
Each party shall pay taxes due on its own profit, income and personnel. The Charterers shall pay all other taxes and dues arising out of the operations or use of the Vessel during the Charter Period. In the event of change in the Area of Operations or change in local regulation and/or interpretation thereof, resulting in an unavoidable and documented change of the Owner's tax liability after the date of entering into the Charter Party or the date of commencement of employment, whichever is the earlier, Hire shall be adjusted accordingly.

25.0 TERMINATION

(a) For Charterers' Convenience – The Charterers may terminate this Charter Party at any time by giving the Owners written notice as stated in Box 14 and the demobilization charge stated in Box 15, as well as Hire or other payments due under the Charter Party.

(b) For Cause – If either party becomes informed of the occurrence of any event described in this Clause that party shall so notify the other party promptly in writing and in any case within 3 days after such information is received. If the occurrence has not ceased within 3 days after such notification has been given, this Charter Party may be terminated by either party, without prejudice to any other rights which either party may have, under any of the following circumstances:

  (i) Requisition – If the government of the state of registry and/or the flag of the Vessel, or any agency thereof, requisition for hire or title or otherwise take possession of the Vessel during the Charter Period.

(ii) Confiscation – If any government, individual or group, whether or not purporting to act as a government or on behalf of any government, confiscates, requisitions, expropriates, seizes or overtakes possession of the Vessel during the Charter Period.

(iii) Bankruptcy – In the event of an order being made or resolution passed for the winding up, dissolution, liquidation or bankruptcy of either party (otherwise than for the purpose of reconstruction or amalgamation) or if a receiver is appointed or if it suspends payment or ceases to carry on business.

(iv) Loss of Vessel – If the Vessel is lost, actually or constructively, or missing, unless the Owners provide a substitute vessel pursuant to Clause 18. In the case of termination, Hire shall cease from the date the Vessel was lost, or, in the event of a constructive total loss, from the date of the event giving rise to such loss. If the date of loss cannot be ascertained or the Vessel is missing, payment of Hire shall cease from the date the Vessel was last reported.

(v) Breakdown – If, at any time during the term of this Charter Party, a breakdown of the Owners' equipment or Vessel results in the Owners being unable to perform their obligations hereunder for a period exceeding that stated in Box 25, unless the Owners provide a substitute vessel pursuant to clause 19.0 Substitute Vessel.

(vi) Force Majeure – If a force majeure condition as defined in Clause 26.0 Force Majeure prevails for a period exceeding 15 consecutive days.

(vii) Default – If either party is in breach of its obligations hereunder.

If terminated for default, Charterer may procure or otherwise obtain, upon such terms and in such manner as Charterer may deem appropriate, supplies or services similar to those terminated, Owners shall be liable to Charterer for any excess costs of such similar supplies or services.

26.0 FORCE MAJEURE

Neither Owners nor the Charterers shall be responsible for failure to perform the terms of this Subcontract when performance is prevented by force majeure provided that: (1) notice and reasonably full particulars are given to the other party and (2) that the cause of such failure or omission is remedied so far as possible with reasonable dispatch. The term force majeure shall mean acts of God, earthquakes, fire, flood, war, civil disturbances, governmentally imposed rules, regulations or moratoriums, or any other cause whatsoever whether similar or dissimilar to the causes herein enumerated, not within the reasonable control of either party which through the exercise of due diligence, a party is unable to foresee or overcome. In no event shall the term force majeure include normal or reasonably foreseeable or reasonably avoidable operational delays. Owners shall notify Charterers of any actual or potential labor dispute that is delaying or threatens to delay the timely performance of this Subcontract.

27.0 WRECK REMOVAL

If the Vessel sinks and becomes a wreck and an obstruction to navigation and has to be removed upon request by any compulsory law or authority having jurisdiction over the area where the wreck is placed, the Owners shall be liable for any and all expenses in connection with the raising, removal, destruction, lighting or marking of the wreck.

28.0 SEVERABILITY CLAUSE

If any portion of this Charter Party is held to be invalid or unenforceable for any reason by a court of governmental authority of competent jurisdiction, then such portion will be deemed to be stricken and the remainder of this Charter Party shall continue in full force and effect.

29.0 DEMISE

Nothing herein contained shall be construed as creating a demise of the Vessel to the Charterers.

30.0 GENERAL RELATIONSHIP

The Owner is not an employee of SAIC for any purpose whatsoever. Owners agrees that in all matters relating to this Subcontract it shall be acting as an independent contractor and shall assume and pay all liabilities and perform all obligations imposed with respect to the performance of this Subcontract. Owners shall have no right, power or authority to create any obligation, expressed or implied, on behalf of Charterer and/or the Government and shall have no authority to represent Charterer as an agent.

31.0 NON-WAIVER OF RIGHTS

The failure of Charterer to insist upon strict performance of any of the terms and conditions in the Subcontract, or to exercise any rights or remedies, shall not be construed as a waiver of its rights to assert any of the same or to rely on any such terms or conditions at any time thereafter. The invalidity in whole or in part of any term or condition of this subcontract shall not affect the validity of other parts hereof.

32.0 APPLICABLE STATE LAW AND COMPLIANCE

This Subcontract shall be governed by and construed in accordance with the laws of the State of California. Owner agrees to comply with the applicable provisions of any federal, state or local law or ordinance and all orders, rules and regulations issued hereunder.

33.0 EXPORT CONTROL COMPLIANCE FOR FOREIGN PERSONS

The subject technology of this Subcontract (together including data, services, and hardware provided hereunder) may be controlled for export purposes under the International Traffic in Arms Regulations (ITAR) controlled by the U.S. Department of State or the Export Administration Regulations (“EAR”) controlled by the U.S. Department of Commerce. ITAR controlled technology may not be exported without prior written authorization and certain EAR technology requires a prior license depending upon its categorization, destination, end-user and end-use. Exports or re-

exports of any U.S. technology to [any destination under U.S. sanction or embargo are forbidden.

Access to certain technology (“Controlled Technology”) by Foreign Persons (working legally in the U.S.), as defined below, may require an export license if the Controlled Technology would require a license prior to delivery to the Foreign Person’s country of origin. SELLER is bound by U.S. export statutes and regulations and shall comply with all U.S. export laws. SELLER shall have full responsibility for obtaining any export licenses or authorization required to fulfill its obligations under this Subcontract.

SELLER hereby certifies that all SELLER employees who have access to the Controlled Technology are U.S. citizens, have permanent U.S. residency or have been granted political asylum or refugee status in accordance with 8 U.S.C. 1324b(a)(3). Any non-citizens who do not meet one of these criteria are “Foreign Persons” within the meaning of this clause but have been authorized under export licenses to perform their work hereunder.

34.0 STANDARDS OF BUSINESS ETHICS & CONDUCT

SAIC believes in fair and open competition and is committed to conducting its business fairly, impartially and in an ethical and proper manner. SAIC is owned and controlled by its employee owners. These characteristics make it imperative that SAIC employees adhere to a particularly high ethical standard. Employee ownership both demands and fosters highly ethical conduct because SAIC can be successful only when employees look after long-term interests of the company and resist pressures to compromise SAIC standards. Buyer’s expectation is that Seller also will conduct its business fairly, impartially and in an ethical and proper manner. If Seller has cause to believe that Buyer or any employee or agent of Buyer has acted improperly or unethically under this agreement/order, Seller shall report such behavior to the SAIC Ethics Hotline (800) 435-4234. Copies of The Science Applications International Corporation (SAIC) code of Ethics and contacts for such reports are available on www.saic.com under Corporate Governance.

35.0 ORDER OF PRECEDENCE

The documents listed below are hereby incorporated by reference. In the event of an inconsistency or conflict between or among the provisions of this Agreement, the inconsistency shall be resolved by giving precedence in the following order:

1. Attachment I: Statement of Work and Schedule dated 4/9/07.
2. Master Vessel Agreement 9-932-080 (Rev. 9/06)
3. Annex A – Vessel Specification Form
4. Schedule B, Part III – Commercial Items - Government

36.0 ENTIRE AGREEMENT

The parties hereby agree that this Subcontract, including all documents incorporated herein by reference, shall constitute the entire agreement and understanding between the parties hereto and shall supersede and replace any and all prior or contemporaneous representations, agreements or understandings of any kind, whether written or oral, relating to the subject matter hereof.

In witness whereof, the duly authorized representatives of Charterer and the Owner have executed this Vessel Time Chartering Agreement on the Dates shown.

OWNER	CHARTERER:
SEA VENTURES, INC.	SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
(Company Name)	
By:	By:
(Signature Date)	(Signature Date)
Name:	Name: Carmen A. Foreman
(Type or Print)	(Type or Print)
Title:	Title: Senior Subcontracts Administrator

IF IN SUPPORT OF U.S. GOVERNMENT PRIME CONTRACT, PROVIDED THAT FAR 52.212-4 AND – 52.212-5 OR 52.244-6 IS IN PRIME SOLICIATION/CONTRACT, YOU MUST INCLUDE THE FOLLOWING CLAUSE:

FEDERAL ACQUISITION REGULATION REFERENCES:

The text of all FAR clauses referred to in this PO shall be that in effect on the date of the prime contract or if no prime contract number is cited, text shall be that in effect on the date of this PO. The following FAR clauses are incorporated by reference and Owner agrees that the following definitions shall apply in interpreting these provisions, except where the context requires different construction: “Government’ shall mean Charterer, Contracting Officer” shall mean Charterer’s Procurement Representative and “Contractor” shall mean Owner. The above definitions shall apply except for those clauses concerning audit and access to records where the Owner has expressly denied Charterer access.

The following clauses are applicable to this Agreement if checked below:

COMMERCIAL ITEM FAR REFERENCES:

☒ 52.219-8 Utilization of Small Business Concerns (15 U.S.C. 637(d)(2)(3))

☒ 52.222-26 Equal Opportunity (E.O. 11246) *

☒ 52.222-35 Affirmative Action for Special Disabled and Vietnam Era Veterans (38 U.S.C. 4212(a))*

☒ 52.222-36 Affirmative Action for Handicapped Workers (29 U.S.C. 793) *

* Required on subcontracts

ANNEX “A” to Time Charter Party for Offshore Service Vessels

VESSEL SPECIFICATION

M/V Coral Queen

ANNEX “B” to Time Charter Party for Offshore Service Vessels

VESSEL SPECIFICATION

M/V Explorer

SCHEDULE B - U.S. GOVERNMENT TERMS AND CONDITIONS

Applicable to all U.S. Government "Commercial Items" Subcontracts

PART III - FAR CLAUSES

1. DEFINITIONS

In all such clauses, unless the context of the clause requires otherwise, the term "Contractor" shall mean Seller, the term "Contract" shall mean this Order, and the terms "Government," "Contracting Officer" and equivalent phrases shall mean Buyer and Buyer's Purchasing Representative, respectively. It is intended that the referenced clauses shall apply to Seller in such manner as is necessary to reflect the position of Seller as a subcontractor to Buyer, to insure Seller's obligations to Buyer and to the United States Government, and to enable Buyer to meet its obligations under its Prime Contract or Subcontract.
The following definitions apply unless otherwise specifically stated:

"Buyer" - the legal entity issuing this Order.
"Commercial Item" – as defined by FAR 2-101
"FAR" - the Federal Acquisition Regulation.
"Prime Contract" - the Government contract under which this Order is issued.
"Purchasing Representative" - Buyer's authorized representative.
"Seller" - the legal entity which contracts with the Buyer.
"This Order" - this contractual instrument, including changes.

2. IDENTIFICATION OF CONTRACT NUMBERS

Government contract numbers shown on this Order shall be included in subcontracts and purchase orders issued by Seller hereunder.

3. COMMERCIAL ITEMS

By FAR 2-101, "Commercial item" means—

(1) Any item, other than real property, that is of a type customarily used by the general public or by non-governmental entities for purposes other than governmental purposes, and—

(i) Has been sold, leased, or licensed to the general public; or

(ii) Has been offered for sale, lease, or license to the general public;

(2) Any item that evolved from an item described in paragraph (1) of this definition through advances in technology or performance and that is not yet available in the commercial marketplace, but will be available in the commercial marketplace in time to satisfy the delivery requirements under a Government solicitation;

(3) Any item that would satisfy a criterion expressed in paragraphs (1) or (2) of this definition, but for—

(i) Modifications of a type customarily available in the commercial marketplace; or

(ii) Minor modifications of a type not customarily available in the commercial marketplace made to meet Federal Government requirements. Minor modifications means modifications that do not significantly alter the nongovernmental function or essential physical characteristics of an item or component, or change the purpose of a process. Factors to be considered in determining whether a modification is minor include the value and size of the modification and the comparative value and size of the final product. Dollar values and percentages may be used as guideposts, but are not conclusive evidence that a modification is minor;

(4) Any combination of items meeting the requirements of paragraphs (1), (2), (3), or (5) of this definition that are of a type customarily combined and sold in combination to the general public;

(5) Installation services, maintenance services, repair services, training services, and other services if— (i) Such services are procured for support of an item referred to in paragraph (1), (2), (3), or (4) of this definition, regardless of whether such services are provided by the same source or at the same time as the item; and

(ii) The source of such services provides similar services contemporaneously to the general public under terms and conditions similar to those offered to the Federal Government;

(6) Services of a type offered and sold competitively in substantial quantities in the commercial marketplace based on established catalog or market prices for specific tasks performed or specific outcomes to be achieved and under standard commercial terms and conditions. This does not include services that are sold based on hourly rates without an established catalog or market price for a specific service performed or a specific outcome to be achieved. For purposes of these services—

(i) “Catalog price” means a price included in a catalog, price list, schedule, or other form that is regularly maintained by the manufacturer or vendor, is either published or otherwise available for inspection by customers, and states prices at which sales are currently, or were last, made to a significant number of buyers constituting the general public; and

(ii) “Market prices” means current prices that are established in the course of ordinary trade between buyers and sellers free to bargain and that can be substantiated through competition or from sources independent of the offerors.

4. DISPUTES

(a) Notwithstanding any provisions herein to the contrary:

(1) If a decision relating to the Prime Contract is made by the Contracting Officer and such decision is also related to this Order, said decision, if binding upon Buyer under the Prime Contract shall in turn be binding upon Buyer and Seller with respect to such matter; provided, however, that if Seller disagrees with any such decision made by the Contracting Officer and Buyer elects not to appeal such decision, Seller shall have the right reserved to Buyer under the Prime Contract with the Government to prosecute a timely appeal in the name of Buyer, as permitted by the contract or by law, Seller to bear its own legal and other costs. If Buyer elects not to appeal any such decision, Buyer agrees to notify Seller in a timely fashion after receipt of such decision and to assist Seller in its prosecution of any such appeal in every reasonable manner. If Buyer elects to appeal any such decision of the Contracting Officer, Buyer agrees to furnish Seller promptly with a copy of such appeal. Any decision upon appeal, if binding upon Buyer, shall in turn be binding upon Seller. Pending the making of any decision, either by the Contracting Officer or on appeal, Seller shall proceed diligently with performance of this Order.

(2) If, as a result of any decision or judgment which is binding upon Seller and Buyer, as provided above, Buyer is unable to obtain payment or reimbursement from the Government under the Prime Contract for, or is required to refund or credit to the Government, any amount with respect to any item or matter for which Buyer has reimbursed or paid Seller, Seller shall, on demand, promptly repay such amount to Buyer. Additionally, pending the final conclusion of any appeal hereunder, Seller shall, on demand, promptly repay any such amount to Buyer. Buyer's maximum liability for any matter connected with or related to this Order which was properly the subject of a claim against the Government under the Prime Contract shall not exceed the amount of Buyer's recovery from the Government.

(3) If this Order is issued by Buyer under a Government Subcontract rather than a Prime Contract, and if Buyer has the right under such Subcontract to appeal a decision made by the Contracting Officer under the Prime Contract in the name of the Prime Contractor (or if Buyer is subject to any arbitrator's decision under the terms of its subcontract), and said decision is also related to this Order, this Disputes Clause shall also apply to Seller in a manner consistent with its intent and similar to its application had this Order been issued by Buyer under a Prime Contract with the Government.

(4) Seller agrees to provide certification that data supporting any claim made by Seller hereunder is made in good faith and that the supporting data is accurate and complete to the best of Seller's knowledge or belief, all in accordance with the requirements of the Contract Disputes Act of 1978 (41USC601-613) and implementing regulations. If any claim of Seller is determined to be based upon fraud or misrepresentation, Seller agrees to defend, indemnify and hold Buyer harmless for any and all liability, loss, cost or expense resulting therefrom.

(b) Any dispute not addressed in paragraph (a) above, will be subject to the disputes clause of Schedule A of this subcontract agreement.

5. OTHER GOVERNMENT PROCUREMENT
Nothing contained herein shall be construed as precluding the Seller from producing items for direct sale to the Government, utilizing therefore all hardware and/or software, including designs, drawings, engineering data or other technical or proprietary information furnished Seller by Buyer, provided the Government has the unrestricted right to permit the use thereof for such purpose.

6. TERMINATION FOR CONVENIENCE
The Buyer may terminate performance of work under this subcontract in whole, or in part if the Purchasing Representative determines that a termination is in the Buyer’s interest. The Buyer shall terminate by delivering to the Seller a Notice of Termination specifying the extent of termination and the effective date. In the event of such termination, the Seller shall immediately stop all work hereunder and shall immediately cause any and all of its suppliers and subcontractors to cease work. Subject to the terms of this order, the Seller shall be paid a percentage of the contract price reflecting the percentage of the work performed prior to the notice of termination, plus reasonable charges the Seller can demonstrate to the satisfaction of the Buyer using its standard record keeping system, have resulted from the termination. The Seller shall not be required to comply with the cost accounting standards or cost principles for this purpose. The Seller shall not be paid for any work performed or costs incurred which reasonably could have been avoided.

7. GOVERNMENT PROPERTY
Seller shall comply with the Government Property requirements contained in FAR clause 52.245-2 if this is a fixed priced contract and FAR clause 52.245-5 (substituting 52.245-2 subparagraph (g) for 52.245-5 subparagraphs (g)(4) if this is a time & material subcontract.

8. ANTI-KICKBACK ACT OF 1986
By accepting this Order, Seller certifies that it has not offered, provided, or solicited and will not offer, provide, or solicit any kickback in violation of the Anti-Kickback Act of 1986 (41 USC §§ 51-58). "Kickback" means any money, fee, commission, credit, gift, gratuity, thing of value, or compensation of any kind that is provided, directly or indirectly, for the purpose of improperly obtaining or rewarding favorable treatment in connection with a prime contract or a subcontract relating to a prime contract. Seller agrees to indemnify, defend, and hold Buyer harmless from and against any losses, liabilities, offsets and expenses (including reasonable attorney's fees) arising out of or relating to Seller's failure to comply with the provisions of the Anti-Kickback Act.

9. FAR CLAUSES APPLICABLE TO THIS ORDER
The clauses in FAR Subpart 52.2 referenced in subparagraph (a) below, in effect on the date of this Order, are incorporated herein and made a part of this Order. To the extent that an earlier version of any such clause is included in the Prime Contract or Subcontract under which this Order is issued, the date of the clause as it appears in such Prime Contract or Subcontract shall be controlling and said version shall be incorporated herein.

(a) The following clauses are applicable to this Order. The extent of the flow down shall be as required by the clause:

Clause & FAR Ref.	**Title of Clause**
52.219-8	Utilization of Small Business Concerns [15 U.S.C. 637(d)(2) and (3)] *In all subcontracts that offer further subcontracting opportunities. If the subcontract (except subcontracts to small business concerns) exceeds $500,000 ($1,000,000 for construction of any public facility), the subcontractor must include 52.219-8 in lower tier subcontracts that offer subcontracting opportunities.*
52.222-26	Equal Opportunity (E.O. 11246)
52.222-35	Equal Opportunity for Special Disabled Veterans, Veterans of the Vietnam Era, and Other Eligible Veterans (38 U.S.C. 4212)
52.222-36	Affirmative Action for Workers with Disabilities (29 U.S.C. 793)
52.222-39	Notification of Employees Rights Concerning Payment of Union Dues or Fees (E.O. 13201)
52.247-64	Preference for Privately-Owned U.S. Flag Commercial Vessels (46 U.S.C. Appendix 1241(b) and 10 U.S.C. 2631)

(b) The Seller shall comply with the FAR clauses in this paragraph (b) that the Buyer has indicated as being incorporated into this order by reference to implement provisions of law or Executive orders applicable to acquisitions of commercial items:

	Clause & FAR Ref.	**Title of Clause**
☒	52.203-6	Restrictions on Subcontractor Sales to the Government, with Alternate I (41 U.S.C. 253g and 10 U.S.C. 2402) *(If order exceeds $100,000)*
☐	52.219-9	Small Business Subcontracting Plan [15 U.S.C. 637(d)(4)] *(if order to a large business and exceeds $500,000)*
☒	52.222-3	Convict Labor (E.O. 11755)
☒	52.222-21	Prohibition of Segregated Facilities (Feb 1999)
☒	52.222-37	Employment Reports on Special Disabled Veterans, Veterans of the Vietnam Era, and Other Eligible Veterans (38 U.S.C. 4212)
☐	52.225-1	Buy American Act – Supplies (41 U.S.C. 10a-10d)
☐	52.225-3	Buy American Act – Free Trade Agreements – Israeli Trade Act (41 U.S.C. 10a-10d, 19 U.S.C. 3301 note, 19 U.S.C. 2112 note, Pub. L. 108-77, 108-78, 108-286 & 109-53)
☐	52.225-3	Alternate I
☐	52.225-3	Alternate II
☐	52.225-5	Trade Agreements (19 U.S.C. 2501, et. seq., 19 U.S.C. 3301 note)
☒	52.225-13	Restrictions on Certain Foreign Purchases (E.O.s, proclamations, and statutes administered by the Office of Foreign Assets Control of the Department of the Treasury)
☐	52.239-1	Privacy or Security Safeguards (5 U.S.C. 552a)

(c) The Seller shall comply with the FAR clauses in this paragraph (c), applicable to commercial services, which the Buyer has indicated as being incorporated in this Order by reference to implement provisions of law or execute orders applicable to acquisitions of commercial items or components:

	Clause & FAR Ref.	**Title of Clause**
☐	52.222-41	Service Contract Act of 1965, as Amended (41 U.S.C. 351, et. Seq.)
☐	52.222-42	Statement of Equivalent Rates for Federal Hires (29 U.S.C. 206 and 41 U.S.C. 351 et. seq.)
☐	52.222-43	Fair Labor Standards Act and Service Contract Act – Price Adjustment (Multiple Year and Option Contracts) (29 U.S.C. 206 and 41 U.S.C. 351 et. seq.)
☐	52.222-44	Fair Labor Standards Act and Service Contract Act – Price Adjustment (29 U.S.C. 206 and 41 U.S.C. 351 et. seq.)

APPENDIX C – TARGET ANALYSIS TABLES

Table Appendix C-1. Target Analysis of the Vieques Skiff Survey Data

Survey Measured Values								Fit Values						
Targ ID	Local X (m)	Local Y (m)	UTM X (m)	UTM Y (m)	Water Depth (m)	Min Signal (nT)	Max Signal (nT)	Burial Depth (m)	Size (m)	Moment (amp m^2)	Incl. (deg)	Azi. (deg)	Fit Qual.	Analyst Comments
S-1	805.36	2104.41	255805.35	2006104.41	3.82	-8.2	32.1	-2.04	0.14	1.1	4	170	0.665	Not an MTA target, poor depth fit
S-2	812.46	2110.22	255812.46	2006110.22	4.03	-1.9	31.0	-2.38	0.13	0.8	38	193	0.921	small target, poor depth FIT
S-3	547.13	2147.66	255547.13	2006147.66	0.79	-48.5	71.2	0.91	0.19	2.6	42	12	0.645	medium sized target
S-4	750.08	2156.28	255750.08	2006156.28	3.62	-21.9	19.2	-2.40	0.10	0.4	2	8	0.511	small target
S-5	794.00	2134.17	255794.00	2006134.17	3.91	-236.8	244.6	1.01	1.07	493.0	4	27	0.963	massive target, good fit, much too big for UXO
S-6	752.99	2198.67	255752.99	2006198.67	3.94	-218.7	160.7	1.11	0.92	308.9	13	358	0.954	Massive target, good fit, cannot be UXO
S-7	554.50	2166.09	255554.50	2006166.09	1.02	-4291.8	5552.2	1.12	1.36	1006.3	16	17	0.936	Massive chunk of steel at the shoreline in very shallow wate
S-8	566.93	2186.07	255566.93	2006186.07	1.14	-23.2	44.7	-0.10	0.10	0.4	23	200	0.808	small target on the surface
S-9	614.30	2208.03	255614.30	2006208.03	1.82	-33.7	34.6	1.04	0.27	8.0	13	5	0.921	large target, good fit
S-10	684.68	2241.42	255684.68	2006241.42	2.96	-16.6	196.7	1.10	0.62	94.9	48	192	0.980	massive target, great fit, could be UXO
S-11	590.33	2224.18	255590.33	2006224.18	1.61	-81.3	66.9	1.34	0.36	18.9	0	355	0.832	very large deep target, may be geology
S-12	586.09	2226.23	255586.09	2006226.23	1.53	-11.3	90.1	0.66	0.23	5.0	63	288	0.764	large target
S-13	631.52	2268.44	255631.52	2006268.44	2.34	-1162.5	1075.3	1.64	1.44	1187.8	2	357	0.954	massive target, very deep, likely geology
S-14	1137.78	2462.38	256137.78	2006462.38	4.60	-36.5	102.9	4.98	1.12	565.4	23	176	0.816	geolgoy
S-15	971.10	2513.80	255971.10	2006513.80	3.37	-49.0	75.2	0.04	0.42	29.2	23	19	0.745	geology
S-16	980.20	2579.82	255980.20	2006579.82	3.31	-28.4	67.8	1.70	0.51	52.1	26	35	0.743	geology
S-17	971.67	2604.59	255971.67	2006604.59	3.37	-57.1	63.5	1.30	0.63	99.4	-1	34	0.627	geology
S-18	1602.78	2350.32	256602.78	2006350.32	2.40	-40.6	33.0	1.07	0.38	22.5	4	342	0.917	likely is geology
S-19	1578.59	2383.17	256578.59	2006383.17	3.16	-37.0	40.9	2.42	0.52	54.9	-22	219	0.677	geology
S-20	1573.51	2412.79	256573.51	2006412.79	3.36	-29.3	22.6	2.03	0.48	45.0	14	2	0.882	geology
S-21	1595.25	2405.47	256595.25	2006405.47	2.67	-19.6	19.1	1.65	0.33	13.7	41	349	0.787	likely is geology
S-22	1644.75	2384.90	256644.75	2006384.90	1.83	-9.8	64.2	2.40	0.41	27.3	52	192	0.882	likely is geology
S-23	1625.88	2408.33	256625.88	2006408.33	1.91	-7.8	30.0	2.64	0.36	19.1	42	42	0.866	geology
S-24	1656.25	2395.74	256656.25	2006395.74	1.82	-60.1	61.7	0.97	0.34	15.6	25	322	0.955	large deep target, may be geology
S-25	1661.34	2399.35	256661.34	2006399.35	1.75	-170.6	68.6	0.56	0.36	19.4	3	321	0.821	very large target, good prospect
S-26	1691.14	2406.69	256691.14	2006406.69	1.58	-72.9	116.3	0.77	0.32	13.0	18	314	0.936	very large target, good prospect
S-27	1707.93	2411.99	256707.93	2006411.99	1.40	-78.8	48.7	1.66	0.33	13.8	5	358	0.584	very large target, may be geology
S-28	1798.91	2445.87	256798.91	2006445.87	1.31	-55.2	86.7	0.71	0.25	6.3	31	9	0.882	large target, good prospect
S-29	1762.74	2428.13	256762.74	2006428.13	1.65	-25.5	80.6	1.63	0.34	16.2	68	16	0.874	very large target, likely geology
S-30	1686.29	2429.29	256686.29	2006429.29	1.65	-26.6	33.6	0.85	0.23	5.0	23	348	0.974	large deep target
S-31	1663.62	2432.77	256663.62	2006432.77	1.82	-45.2	47.2	1.42	0.38	22.2	26	22	0.835	likely is geology
S-32	1631.10	2435.51	256631.10	2006435.51	2.02	-35.8	30.3	2.71	0.46	38.4	13	349	0.933	looks like geology
S-33	1646.89	2499.36	256646.89	2006499.36	2.29	-39.1	95.8	2.37	0.40	25.2	79	90	0.334	geology
S-34	1663.47	2502.04	256663.47	2006502.04	2.21	-24.8	178.9	1.19	0.50	50.4	51	35	0.896	massive target, may be, may not be, geology
S-35	1678.71	2460.29	256678.71	2006460.29	1.88	-39.2	90.2	2.16	0.48	45.3	42	11	0.934	geology
S-36	1669.96	2471.39	256669.96	2006471.39	2.05	-24.4	46.1	0.98	0.36	17.9	-1	320	0.918	very large target, may be geology
S-37	1691.89	2498.37	256691.89	2006498.37	1.98	-93.7	196.5	1.63	0.58	79.5	43	345	0.974	massive target, great fit, does not look like geology
S-38	1716.14	2492.60	256716.13	2006492.60	1.69	-84.3	41.6	0.99	0.33	14.5	-1	341	0.754	geology
S-39	1768.43	2466.47	256768.43	2006466.47	1.44	-42.3	43.5	0.58	0.22	4.3	21	318	0.899	large target, may be geology
S-40	1778.99	2469.84	256778.99	2006469.84	1.38	-68.8	61.0	0.58	0.40	26.4	0	1	0.881	very large target, partial signature
S-41	1781.00	2499.42	256781.00	2006499.42	1.28	-51.9	143.6	1.71	0.39	24.4	73	90	0.758	very large deep target, does not look like geology
S-42	1793.85	2510.19	256793.85	2006510.19	1.09	-24.4	76.0	0.82	0.19	2.7	75	58	0.824	medium sized target
S-43	1766.26	2535.54	256766.26	2006535.54	1.50	-460.0	173.7	0.58	0.46	38.7	-4	317	0.930	very large target, mostly negative signal, good prospect
S-44	1752.68	2556.02	256752.68	2006556.02	1.50	-82.4	51.8	0.40	0.25	5.9	-5	21	0.936	large target, good prospect
S-45	1757.64	2565.39	256757.64	2006565.39	1.45	-38.5	66.9	1.43	0.32	13.2	30	289	0.665	likely is geology
S-46	1746.76	2535.14	256746.76	2006535.14	1.75	-98.1	98.8	1.21	0.43	31.8	23	355	0.945	very large deep target, geology?
S-47	1746.11	2526.61	256746.11	2006526.62	1.65	-115.4	268.9	0.58	0.42	29.0	8	109	0.977	large target, inverted signal
S-48	1727.43	2545.91	256727.43	2006545.91	1.78	-37.5	30.9	0.88	0.26	6.9	4	338	0.938	large deep target
S-49	1719.65	2521.32	256719.65	2006521.32	1.77	-43.5	68.4	1.22	0.31	11.6	77	90	0.779	very large deep target
S-50	1713.63	2529.49	256713.63	2006529.49	1.84	-12.3	38.9	1.82	0.31	12.3	30	100	0.824	geology
S-51	1714.34	2554.59	256714.34	2006554.59	1.96	-18.8	80.2	1.42	0.37	20.2	78	147	0.965	very large deep target, geology?
S-52	1686.76	2540.62	256686.76	2006540.62	2.12	-166.7	85.0	0.85	0.48	43.1	1	25	0.923	massive target, geology?
S-53	1669.11	2522.58	256669.11	2006522.58	2.24	-84.3	84.9	0.84	0.44	33.6	5	341	0.971	massive target, too deep to dig?
S-54	1662.43	2548.51	256662.43	2006548.51	2.50	-66.4	194.6	0.81	0.52	56.4	50	40	0.947	excellent target, too deep to dig?
S-55	1625.32	2516.12	256625.32	2006516.12	2.73	-79.3	70.4	0.90	0.47	42.3	19	344	0.887	massive deep target, geology?
S-56	1638.18	2558.92	256638.18	2006558.92	2.70	-12.6	39.1	0.71	0.30	10.5	89	90	0.765	very large target
S-57	1627.49	2551.02	256627.49	2006551.02	2.79	-44.9	97.2	1.69	0.55	67.2	44	330	0.961	too big and deep for single UXO
S-58	1601.79	2537.60	256601.79	2006537.60	3.33	-222.4	163.2	1.17	0.82	216.4	9	3	0.970	excellent target, too big for UXO
S-59	1593.57	2554.27	256593.57	2006554.27	3.49	-131.8	51.8	0.91	0.62	95.9	-12	358	0.923	looks like geology
S-60	1169.14	2532.30	256169.14	2006532.30	3.12	-137.1	77.6	-0.03	0.49	47.9	-18	22	0.868	likely is geology
S-61	1435.23	2581.48	256435.23	2006581.48	2.37	-164.7	141.7	3.92	0.96	355.8	17	354	0.780	must be geology
S-62	1650.47	2591.06	256650.47	2006591.06	2.81	-189.2	362.3	1.82	0.87	262.0	49	23	0.874	area of concrete rubble, piling?
S-63	1717.22	2576.48	256717.22	2006576.48	1.83	-168.4	143.3	1.11	0.49	45.6	13	21	0.945	in area of concrete rubble, could be UXO
S-64	1655.40	2621.81	256655.40	2006621.81	2.84	-1636.6	1034.9	4.14	2.22	4364.6	-13	339	0.771	concrete rubble

Table Appendix C-2. Target Analysis of MTA Vieques Survey Data

Survey Measured Values								Fit Values						
Targ ID	Local X (m)	Local Y (m)	UTM X (m)	UTM Y (m)	Water Depth (m)	Min Signal (nT)	Max Signal (nT)	Burial Depth (m)	Size (m)	Moment (amp m^2)	Incl. (deg)	Azi. (deg)	Fit Qual.	Analyst Comments
1	1160.23	1032.57	256160.23	2005032.57	6.79	-19	11	-0.09	0.140	1.093	8	329	0.879	partial signature target on surface
2	1181.39	1028.84	256181.39	2005028.84	6.64	-2	11	0.08	0.107	0.496	74	250	0.851	small target on surface
3	1169.76	1053.06	256169.76	2005053.06	6.33	-7	8	0.02	0.105	0.465	37	306	0.641	small target on the surface
4	1296.55	1072.55	256296.55	2005072.55	6.72	-141	121	1.17	0.404	26.445	15	320	0.902	very large target, analyzes as 1 m deep
5	1267.26	1087.67	256267.26	2005087.67	6.16	-28	7	0.14	0.174	2.100	-18	338	0.888	signature mostly remnant, likely clutter on surface
6	1211.61	1092.51	256211.61	2005092.51	5.50	-6	51	0.32	0.236	5.262	76	277	0.958	good target, 1 ft deep
7	1175.09	1126.04	256175.09	2005126.04	5.60	-13	49	0.99	0.288	9.549	54	54	0.895	excellent target, analyzes as 1 m deep
8	1218.52	1165.37	256218.52	2005165.37	5.83	-91	123	1.17	0.527	58.585	2	71	0.939	very large target, complex signature, 1 m deep
9	1175.22	1193.51	256175.22	2005193.51	7.58	-9	13	1.75	0.190	2.750	-3	77	0.352	looks like multiple clutter targets
10	1191.28	1194.33	256191.28	2005194.33	7.19	-20	18	0.83	0.264	7.385	-12	265	0.796	signature is mostly remnant
11	1277.56	1235.30	256277.56	2005235.30	7.36	-12	13	0.53	0.191	2.803	17	337	0.888	medium target, 0.5 m deep
12	1163.17	1219.17	256163.17	2005219.17	7.60	-15	10	-0.04	0.166	1.834	6	351	0.920	medium target on surface
13	1164.12	1245.74	256164.12	2005245.74	8.74	-19	35	0.14	0.214	3.922	53	340	0.930	large target on the surface
14	1175.11	1258.20	256175.11	2005258.20	8.93	-22	45	2.41	0.435	32.938	32	46	0.943	very large target, buried deep
15	1169.47	1265.37	256169.47	2005265.37	9.00	-10	17	-0.02	0.144	1.185	45	359	0.770	medium size target on surface
16	1189.66	1270.97	256189.66	2005270.97	9.21	-14	22	0.95	0.239	5.470	57	249	0.736	partail signature, medium sized target
17	1211.07	1243.37	256211.07	2005243.37	8.54	-16	37	3.14	0.452	36.826	48	76	0.906	very large target, analyzes as very deep
18	1267.87	1248.49	256267.86	2005248.49	7.56	-41	307	0.38	0.358	18.306	87	258	0.453	large target, 1 ft deep
19	1269.90	1262.93	256269.90	2005262.93	7.74	-8	22	0.1	0.141	1.125	20	152	0.834	medium target, inverted signal
20	1274.92	1262.18	256274.92	2005262.18	7.78	-8	26	0.79	0.193	2.875	82	27	0.825	large target
21	1319.26	1268.07	256319.26	2005268.07	7.41	-10	91	0.16	0.300	10.848	37	175	0.953	large target on the surface
22	1290.56	1283.25	256290.56	2005283.25	8.00	-5	17	2.57	0.183	2.461	70	293	0.601	large target, poor fit
23	1214.68	1308.47	256214.68	2005308.47	9.56	-21	34	2.27	0.351	17.357	16	241	0.693	large target, partial signature, don't trust depth
24	1266.12	1316.85	256266.12	2005316.85	8.78	-30	29	0.35	0.329	14.284	21	349	0.858	large target, partial signature
25	1290.12	1327.55	256290.12	2005327.55	8.10	-78	208	-0.72	0.255	6.634	41	8	0.749	large target, poor fit, above bottom
26	1303.95	1320.96	256303.95	2005320.96	7.81	-89	145	0.09	0.398	25.238	50	1	0.852	very large target on surface
27	1321.64	1337.23	256321.64	2005337.23	6.84	-173	138	-1.21	0.352	17.442	53	343	0.522	very complex signature, fits above surface, likely is junk pile
28	1327.50	1357.48	256327.50	2005357.48	6.31	-35	41	-0.67	0.471	41.828	18	9	0.860	very large target, complex signature, above bottom surface
29	1291.22	1354.75	256291.22	2005354.75	8.17	-25	21	3.8	0.454	37.534	20	359	0.861	very large target, partial signature, don't believe depth
30	1289.07	1383.47	256289.07	2005383.47	8.19	-25	29	-0.87	0.135	0.982	13	354	0.615	lousy fit, don't believe size or depth
31	1190.72	1327.15	256190.72	2005327.15	9.78	-55	418	2.12	0.807	210.195	83	182	0.884	huge target, analyzes as deep
32	1206.91	1334.53	256206.91	2005334.53	9.55	-149	174	0.3	0.388	23.391	16	342	0.880	very large target, on surface
33	1206.10	1345.69	256206.10	2005345.69	9.32	-573	400	1.8	0.626	98.363	-4	7	0.804	huge target, may be ship wreck junk
34	1196.91	1352.77	256196.91	2005352.77	9.46	-151	358	0.08	0.457	38.151	48	359	0.963	very large target on surface
35	1161.69	1345.31	256161.69	2005345.31	9.67	-10	13	0.13	0.157	1.542	13	17	0.901	small target, shallow
36	1274.48	1340.87	256274.48	2005340.87	8.68	-115	56	0.07	0.429	31.483	16	343	0.876	very large target on surface
37	1350.12	1391.47	256350.12	2005391.47	6.42	-14	40	-0.04	0.444	35.081	59	359	0.904	very large target, on surface
38	1296.67	1393.55	256296.67	2005393.55	8.03	-15	36	-0.16	0.180	2.342	87	284	0.575	looks like pile of clutter
39	1295.89	1404.67	256295.89	2005404.67	7.73	-218	209	-0.33	0.429	31.473	24	9	0.873	very large target on the surface
40	1298.52	1413.89	256298.52	2005413.89	7.75	-117	49	-0.33	0.322	13.306	23	324	0.881	large target on surface
41	1092.64	1440.35	256092.64	2005440.35	8.47	-27	36	0.48	0.232	5.011	29	3	0.862	medium target
42	1120.76	1451.70	256120.76	2005451.70	8.40	-12	17	0.69	0.188	2.651	18	1	0.893	medium target 2 ft deep
43	1196.04	1455.19	256196.04	2005455.19	8.40	-44	64	0.66	0.349	16.941	4	85	0.970	large target, partial signature
44	1222.40	1444.82	256222.40	2005444.82	8.45	-16	21	0.72	0.239	5.444	60	335	0.890	medium target, lots of clutter around
45	1232.45	1444.33	256232.45	2005444.33	8.56	-11	16	0.69	0.182	2.401	69	41	0.639	looks like multiple objects
46	1275.89	1418.35	256275.89	2005418.35	8.05	-10	13	0.19	0.161	1.659	18	77	0.761	medium target, difficult fit
47	1289.57	1442.74	256289.57	2005442.74	7.81	-43	54	0.83	0.393	24.219	26	359	0.938	large target, 1 m deep
48	1302.86	1470.90	256302.86	2005470.90	7.63	-7	17	-0.15	0.229	4.803	53	344	0.813	medium target on surface
49	1302.37	1481.91	256302.37	2005481.91	7.83	-10	24	-1.59	0.247	6.048	64	322	0.713	Killian Clutter?
50	1282.18	1454.80	256282.18	2005454.80	8.12	-76	64	0.36	0.558	69.362	4	26	0.941	huge shallow target
51	1263.30	1475.64	256263.30	2005475.64	8.05	-64	61	0.14	0.311	12.002	18	306	0.864	large target, partial signature
52	1227.43	1469.90	256227.43	2005469.90	8.07	-10	14	-0.16	0.165	1.782	0	238	0.807	looks like clutter
53	1208.01	1460.69	256208.01	2005460.69	8.27	-10	19	0.76	0.193	2.895	39	263	0.907	good target, 2 ft deep
54	1211.00	1474.59	256211.00	2005474.59	8.10	-59	65	1.63	0.328	14.068	23	344	0.726	excellent target, poor fit
55	1195.34	1476.85	256195.34	2005476.85	8.35	-12	43	0.56	0.248	6.120	56	13	0.848	large target, partial signature
56	1159.90	1477.71	256159.90	2005477.71	8.52	-11	13	0.52	0.193	2.898	10	54	0.862	large target
57	1151.53	1478.68	256151.53	2005478.68	8.40	-32	46	0.53	0.278	8.552	23	224	0.766	large target
58	1117.41	1456.89	256117.41	2005456.89	8.42	-7	9	0.18	0.149	1.335	3	135	0.948	medium target, on surface
59	1109.41	1470.14	256109.41	2005470.14	8.53	-14	57	0.33	0.223	4.438	33	70	0.611	partial signature, poor fit
60	1078.16	1458.38	256078.16	2005458.38	8.37	-12	43	1.1	0.232	5.024	26	350	0.332	partial signature, poor fit
61	1070.60	1465.18	256070.60	2005465.18	8.14	-96	71	0.76	0.410	27.490	7	249	0.906	very large target
62	1029.27	1481.91	256029.27	2005481.91	8.01	-10	46	0.93	0.265	7.436	47	295	0.790	large target, partial signature
63	1081.07	1501.75	256081.07	2005501.75	8.24	-67	81	2.17	0.436	33.061	18	78	0.626	very large target, partial signature
64	1094.07	1492.01	256094.07	2005492.01	8.10	-32	14	1.72	0.227	4.706	-10	340	0.561	6 overlapping passes, don't trust
65	1107.67	1511.65	256107.67	2005511.65	8.00	-11	24	1.72	0.219	4.181	71	323	0.701	measured in turn, don't trust
66	1173.74	1488.94	256173.74	2005488.94	8.19	-101	110	0.1	0.322	13.327	1	91	0.937	large target, on surface
67	1182.30	1494.27	256182.30	2005494.27	8.39	-67	33	0.07	0.263	7.236	-5	31	0.966	on surface, mostly remnant signature

Table Appendix C-2. Continued

Survey Measured Values								Fit Values						
Targ ID	Local X (m)	Local Y (m)	UTM X (m)	UTM Y (m)	Water Depth (m)	Min Signal (nT)	Max Signal (nT)	Burial Depth (m)	Size (m)	Moment (amp m^2)	Incl. (deg)	Azi. (deg)	Fit Qual.	Analyst Comments
70	1337.44	1524.40	256337.44	2005524.40	8.10	-593	526	-2.14	1.204	698.823	7	352	0.808	killian wreck
71	1345.85	1522.14	256345.85	2005522.14	8.08	-385	2219	-1.65	1.706	1984.486	-19	105	0.677	killian wreck
72	1346.27	1516.00	256346.27	2005516.00	8.04	-1241	811	0.99	1.861	2577.044	-4	357	0.677	killian wreck
73	1364.00	1509.66	256364.00	2005509.66	7.35	-5709	10575	0.25	3.292	*********	26	187	0.422	killian wreck
74	1370.97	1494.28	256370.97	2005494.28	8.17	-2608	17788	0.19	8.003	*********	60	206	0.922	killian wreck
75	1482.93	1558.23	256482.93	2005558.24	9.53	-218	261	0.75	0.511	53.468	18	332	0.895	huge target
76	1362.72	1537.06	256362.72	2005537.06	8.12	-114	299	-0.87	0.848	243.823	17	152	0.652	killian wreck
77	1352.93	1543.46	256352.93	2005543.46	7.73	-720	242	-1.18	1.150	608.874	-63	191	0.889	killian wreck
78	1340.21	1545.78	256340.21	2005545.78	9.66	-826	4480	-1.17	3.067	*********	41	179	0.939	killian wreck
79	1336.03	1560.13	256336.03	2005560.13	7.90	-472	1019	-0.19	1.599	1634.362	27	178	0.713	killian wreck
80	1325.87	1553.53	256325.87	2005553.53	7.99	-2937	858	0.88	2.537	6531.992	-88	218	0.839	killian wreck
81	1226.85	1525.54	256226.85	2005525.54	8.00	-41	42	0.14	0.285	9.302	8	341	0.932	large target, on surface
82	1173.98	1538.59	256173.98	2005538.60	7.87	-11	23	0.29	0.187	2.612	5	259	0.940	large target, shallow
83	1153.68	1495.08	256153.68	2005495.08	8.10	-19	9	-0.13	0.142	1.149	-1	56	0.834	medium target, on surface
84	1138.43	1518.32	256138.43	2005518.32	8.29	-37	39	0.42	0.242	5.702	17	120	0.626	large target, poor fit
85	1115.99	1533.68	256115.99	2005533.68	8.06	-71	56	0.74	0.337	15.249	-12	247	0.790	partial signature, don't trust
86	1104.63	1538.67	256104.63	2005538.67	8.28	-18	55	0.21	0.248	6.131	0	188	0.863	large target, shallow
87	1094.57	1544.16	256094.57	2005544.16	8.25	-13	14	1.19	0.190	2.742	-15	94	0.713	looks like clutter
88	1059.21	1539.52	256059.21	2005539.52	8.14	-8	15	0.75	0.188	2.643	3	91	0.688	medium target, poor fit
89	1029.43	1572.08	256029.43	2005572.08	7.83	-47	46	0.77	0.288	9.532	7	289	0.913	large target, partial signature
90	1042.40	1588.94	256042.40	2005588.94	7.93	-40	18	0.83	0.295	10.277	-11	14	0.924	large target, deep
91	1056.38	1554.63	256056.38	2005554.63	8.01	-15	14	1.29	0.241	5.623	10	265	0.765	large target, poor fit, don't trust depth
92	1090.20	1564.12	256090.20	2005564.12	8.13	-34	20	0.71	0.316	12.622	2	11	0.886	large target, inverted signature
93	1105.27	1573.20	256105.27	2005573.20	8.31	-46	75	0.15	0.301	10.860	0	211	0.959	very large target on surface
94	1116.43	1555.62	256116.43	2005555.62	8.05	-45	10	0.59	0.242	5.703	-52	205	0.948	large target, all remnant
95	1114.98	1574.87	256114.98	2005574.87	8.14	-113	75	0.54	0.360	18.640	5	43	0.919	very large shallow target, partial signature
96	1131.43	1552.76	256131.43	2005552.76	8.25	-52	115	0.21	0.316	12.632	28	76	0.891	large shallow target, good prospect
97	1130.99	1568.80	256130.99	2005568.80	8.27	-127	91	0.12	0.402	25.937	-6	34	0.934	very large shallow target, some remnant
98	1119.04	1583.75	256119.04	2005583.75	8.14	-51	44	0.47	0.309	11.857	-14	183	0.876	large target, inverted signature
99	1128.00	1587.77	256128.00	2005587.77	7.86	-33	25	0.58	0.235	5.172	12	339	0.957	large target, good prospect
100	1151.39	1562.99	256151.39	2005562.99	8.14	-127	83	0.59	0.376	21.349	-3	345	0.942	very large target, 2 ft deep
101	1144.84	1580.83	256144.84	2005580.83	7.95	-29	36	-0.01	0.173	2.083	6	102	0.683	medium sized target on surface
102	1156.83	1578.84	256156.83	2005578.84	8.21	-37	25	1	0.291	9.856	-54	215	0.900	all remnant, deep
103	1175.19	1559.90	256175.19	2005559.90	8.05	-26	16	0.41	0.196	2.997	-14	342	0.941	likely is clutter
104	1179.61	1563.40	256179.61	2005563.40	8.03	-10	25	1.15	0.254	6.569	41	285	0.926	large deep target
105	1222.05	1583.07	256222.05	2005583.07	8.05	-14	61	1	0.304	11.244	67	292	0.964	large deep target
106	1239.35	1569.02	256239.35	2005569.02	8.05	-15	26	0.45	0.228	4.746	28	342	0.804	large target, partial signature
107	1405.57	1577.94	256405.57	2005577.94	8.80	-17	53	0.65	0.254	6.526	27	195	0.914	large target, 2 ft deep
108	1419.33	1575.46	256419.33	2005575.46	8.83	-35	32	0.9	0.264	7.353	16	326	0.882	large target, partial signature
109	1422.38	1586.74	256422.38	2005586.74	9.27	-10	16	-0.37	0.128	0.836	85	58	0.705	small shallow target, poor fit
110	1474.78	1566.19	256474.78	2005566.19	9.15	-100	197	0.43	0.379	21.799	44	15	0.901	large excellent target
111	1485.53	1586.47	256485.53	2005586.47	9.43	-127	65	-0.12	0.350	17.097	-4	52	0.587	large target on surface, partial signature
112	1512.24	1579.20	256512.24	2005579.20	9.48	-9	28	0.33	0.199	3.131	88	256	0.661	large target, partial signature
113	1525.84	1575.82	256525.84	2005575.82	9.38	-17	23	1.72	0.360	18.635	9	10	0.839	large target, partial signature
114	1539.49	1610.75	256539.49	2005610.75	9.58	-6	27	0.31	0.171	1.994	70	245	0.863	medium sized shallow target
115	1529.30	1623.80	256529.30	2005623.80	9.27	-11	23	3.15	0.401	25.832	41	31	0.919	very large, very deep target, looks like geology
116	1471.53	1626.66	256471.53	2005626.66	9.43	-74	92	1.97	0.366	19.648	21	344	0.613	very large, very deep, poor fit
117	1436.70	1607.08	256436.70	2005607.08	9.28	-14	66	0.99	0.330	14.438	27	206	0.900	large target, inverted signal
118	1419.39	1593.47	256419.39	2005593.47	9.17	-11	18	-0.94	0.099	0.388	38	18	0.363	killian clutter?
119	1403.95	1594.31	256403.94	2005594.31	8.95	-5	29	2.96	0.339	15.645	66	166	0.933	looks like clutter
120	1406.00	1609.37	256406.00	2005609.37	9.05	-53	30	0.52	0.300	10.853	-4	14	0.937	inverted, looks like multiple objects
121	1426.16	1629.93	256426.16	2005629.93	9.29	-41	55	0.6	0.317	12.712	18	299	0.969	large target, good prospect
122	1413.35	1621.26	256413.35	2005621.26	9.18	-50	30	1.2	0.322	13.313	-19	147	0.576	large target, inverted, poor fit
123	1351.11	1588.22	256351.11	2005588.22	8.69	-30	41	-1.7	0.543	63.942	16	6	0.809	killian wreck junk
124	1355.72	1607.35	256355.72	2005607.35	8.58	-236	42	-4.67	0.213	3.892	-69	273	0.095	cable or steel pole, note depth
125	1229.36	1603.36	256229.36	2005603.36	8.09	-33	16	0.18	0.214	3.894	-2	351	0.945	mostly remnant, likely clutter
126	1237.79	1609.89	256237.79	2005609.89	8.20	-35	43	0.29	0.270	7.855	22	317	0.946	large shallow target, good prospect
127	1245.63	1617.42	256245.63	2005617.42	8.08	-22	22	1.9	0.281	8.872	2	88	0.526	looks like clutter
128	1184.66	1594.95	256184.66	2005594.95	8.06	-14	22	0.5	0.187	2.609	-12	199	0.899	inverted target, likely junk
129	1193.19	1601.15	256193.19	2005601.15	8.13	-4	22	-0.01	0.128	0.836	84	145	0.804	small target on surface, part signature
130	1144.46	1597.50	256144.46	2005597.50	8.13	-37	71	1.44	0.334	14.961	43	345	0.730	large target partial signature, dont trust depth
131	1131.33	1613.88	256131.33	2005613.88	7.90	-9	12	1.32	0.195	2.961	19	29	0.912	medium target, deep
132	1124.56	1616.74	256124.56	2005616.74	8.02	-9	44	-0.12	0.365	19.508	79	199	0.826	large shallow target, partial signature
133	1107.24	1594.35	256107.24	2005594.35	8.31	-10	16	0.13	0.156	1.510	73	101	0.580	medium sized shallow target, poor fit
134	1097.90	1596.60	256097.90	2005596.60	8.24	-43	92	0.38	0.354	17.783	30	318	0.902	large shallow target, partial signature
135	1097.97	1607.37	256097.97	2005607.37	7.98	-46	68	0.23	0.299	10.701	2	126	0.884	all remnant, likely junk
136	1092.77	1601.12	256092.77	2005601.12	8.13	-44	17	-0.05	0.220	4.241	-10	282	0.793	all remnant signature, likely junk
137	1089.67	1619.56	256089.67	2005619.56	7.67	-18	20	0.33	0.208	3.612	30	356	0.971	large shallow target
138	1055.48	1609.40	256055.48	2005609.40	7.72	-21	34	0.66	0.257	6.778	32	2	0.891	large target, 2 ft deep
139	1030.04	1604.31	256030.04	2005604.31	7.79	-9	12	0.68	0.169	1.926	5	213	0.903	medium target, inverted
140	1015.46	1616.85	256015.46	2005616.85	7.46	-19	21	0.81	0.240	5.532	-3	102	0.900	large target, deep

Table Appendix C-2. Continued

Survey Measured Values								Fit Values						
Targ ID	Local X (m)	Local Y (m)	UTM X (m)	UTM Y (m)	Water Depth (m)	Min Signal (nT)	Max Signal (nT)	Burial Depth (m)	Size (m)	Moment (amp m^2)	Incl. (deg)	Azi. (deg)	Fit Qual.	Analyst Comments
148	1109.08	1625.02	256109.08	2005625.02	7.71	-61	64	0.51	0.301	10.876	11	295	0.976	excellent target
149	1094.17	1642.12	256094.17	2005642.12	7.65	-11	32	0.28	0.203	3.348	25	241	0.949	medium sized shallow target, mildly inverted
150	1088.81	1661.59	256088.81	2005661.59	7.60	-15	7	0.21	0.169	1.922	-5	343	0.823	medium sized target, inverted signature
151	1107.53	1658.11	256107.53	2005658.11	7.88	-27	22	0.33	0.215	3.954	3	59	0.906	medium sized target
152	1114.09	1655.77	256114.09	2005655.77	7.78	-24	14	0.02	0.170	1.950	-3	351	0.858	looks like clutter on surface
153	1118.86	1653.30	256118.86	2005653.30	7.76	-18	11	0.68	0.216	4.007	5	325	0.918	looks like clutter
154	1136.13	1641.04	256136.13	2005641.04	7.74	-5	24	1.06	0.224	4.507	24	142	0.932	may be multiple objects
155	1155.66	1663.68	256155.66	2005663.68	8.01	-19	21	1.35	0.283	9.038	22	352	0.830	partial signature, clutter?
156	1173.64	1636.95	256173.64	2005636.95	8.29	-97	57	0.22	0.358	18.388	-7	56	0.967	large shallow target, mildly inverted, good
157	1181.86	1625.04	256181.86	2005625.04	8.37	-56	60	0.38	0.386	23.061	24	80	0.939	large shallow target, mildly inverted
158	1214.21	1629.91	256214.21	2005629.91	8.29	-13	29	0.69	0.239	5.475	50	322	0.619	large target, poor fit because of shallow passes
159	1203.11	1666.74	256203.11	2005666.74	8.23	-9	12	0.35	0.174	2.093	19	260	0.738	looks like clutter
160	1228.63	1646.85	256228.63	2005646.85	8.28	-55	49	0.12	0.276	8.426	15	39	0.975	large shallow target, good prospect
161	1253.99	1638.41	256253.99	2005638.41	8.38	-55	69	0.62	0.348	16.830	12	68	0.929	very large target, good prospect
162	1342.72	1659.26	256342.72	2005659.26	9.40	-393	385	0.74	1.663	1841.190	-16	180	0.747	killian pieces
163	1346.57	1686.80	256346.57	2005686.80	9.22	-315	781	0.22	1.839	2489.728	6	187	0.813	Killian Pieces
164	1375.00	1665.90	256375.00	2005665.90	9.35	-21	69	-2.27	0.663	116.434	73	17	0.868	Killian Piece
165	1444.06	1649.57	256444.06	2005649.57	9.33	-18	23	0.44	0.196	3.020	3	162	0.918	inverted signature, large object
166	1443.27	1665.44	256443.27	2005665.44	9.34	-28	37	0.62	0.260	7.025	22	341	0.942	large target, good prospect
167	1450.06	1669.94	256450.06	2005669.94	9.49	-62	73	1.13	0.346	16.525	-4	118	0.771	very large object, inverted signature
168	1459.03	1670.09	256459.03	2005670.09	9.25	-41	39	0.6	0.283	9.098	1	18	0.838	large target with clutter around
169	1493.87	1638.87	256493.87	2005638.87	9.43	-6	20	0.86	0.200	3.219	55	293	0.909	good target, deep
170	1500.88	1670.10	256500.88	2005670.10	9.06	-12	16	0.42	0.184	2.503	28	7	0.709	looks like clutter
171	1513.50	1676.29	256513.50	2005676.29	9.19	-15	25	0.52	0.203	3.327	27	359	0.823	partial signature, good target
172	1520.33	1689.23	256520.33	2005689.23	9.57	-25	14	0.55	0.224	4.511	1	288	0.829	large target
173	1517.30	1695.09	256517.30	2005695.09	9.57	-66	62	0	0.275	8.346	19	358	0.875	large target on surface, partial signature
174	1537.68	1721.15	256537.67	2005721.15	9.15	-49	88	0.25	0.318	12.841	8	55	0.914	very large shallow target, good prospect
175	1501.45	1699.21	256501.45	2005699.21	9.30	-94	101	0.26	0.388	23.398	-19	235	0.798	2 objects, 1.5 m apart E-W
176	1498.93	1704.68	256498.93	2005704.68	9.11	-59	35	0.34	0.254	6.583	25	48	0.760	several objects in pile
177	1509.33	1717.91	256509.33	2005717.91	8.87	-14	47	0.55	0.233	5.075	22	239	0.878	large target, mildly inverted
178	1460.99	1722.15	256460.99	2005722.15	8.96	-79	107	0.54	0.359	18.460	42	327	0.870	very large target, good prospect
179	1436.70	1707.57	256436.70	2005707.57	9.14	-64	49	0.68	0.308	11.656	8	342	0.939	excellent target
180	1427.82	1724.57	256427.82	2005724.57	8.95	-12	25	1.07	0.268	7.680	17	177	0.932	large deep target
181	1414.38	1727.48	256414.38	2005727.48	8.87	-85	48	0.89	0.361	18.865	-6	29	0.929	very large target, signal inverted
182	1306.93	1703.74	256306.93	2005703.74	8.66	-29	53	1.26	0.316	12.636	43	337	0.914	very large deep target
183	1287.71	1703.27	256287.71	2005703.27	8.88	-21	44	0.98	0.316	12.566	44	340	0.867	two targets 2 m apart N-S
184	1280.61	1703.27	256280.61	2005703.27	8.65	-23	38	0.74	0.264	7.398	46	10	0.924	large target, good prospect
185	1279.41	1710.49	256279.41	2005710.49	8.60	-27	41	0.46	0.292	10.009	11	118	0.941	large inverted target
186	1209.88	1678.92	256209.88	2005678.92	8.08	-24	15	0.69	0.201	3.261	-9	288	0.899	large target
187	1207.86	1703.97	256207.86	2005703.97	8.17	-33	21	0.5	0.263	7.268	-3	26	0.919	large target, mildly inverted signature
188	1179.12	1688.61	256179.12	2005688.61	8.24	-16	15	-0.17	0.151	1.371	20	331	0.817	medium target on surface
189	1177.22	1682.97	256177.22	2005682.97	8.07	-102	65	0.23	0.314	12.380	-1	44	0.978	very large target, mildly inverted, note 188 is close
190	1178.34	1719.39	256178.34	2005719.39	8.01	-87	111	0.14	0.354	17.682	-1	112	0.986	very large shallow inverted target
191	1158.72	1716.76	256158.72	2005716.76	7.79	-15	14	1.42	0.247	6.043	12	345	0.826	large very deep target
192	1128.77	1719.12	256128.77	2005719.12	7.70	-8	22	-0.3	0.126	0.804	32	199	0.829	small target on surface
193	1109.01	1706.72	256109.01	2005706.72	7.59	-4	15	0.26	0.149	1.333	4	178	0.910	small shallow target
194	1103.47	1720.94	256103.47	2005720.94	7.57	-13	13	0.8	0.210	3.714	17	354	0.875	medium sized target
195	1102.78	1695.20	256102.78	2005695.20	7.55	-23	15	0.47	0.229	4.789	16	349	0.883	large target, very inverted
196	1148.95	1703.16	256148.95	2005703.16	7.79	-115	73	0.42	0.370	20.275	-1	317	0.973	very large inverted target
197	1140.82	1675.56	256140.82	2005675.56	7.83	-25	29	0.81	0.226	4.631	46	332	0.699	large deep target
198	1145.99	1672.96	256145.99	2005672.96	7.98	-33	63	0.59	0.323	13.511	39	286	0.797	very large target, good prospect
199	1058.90	1669.49	256058.90	2005669.49	7.62	-56	84	0.67	0.380	21.946	15	273	0.966	very large target, excellent prospect
200	1051.45	1682.89	256051.45	2005682.89	7.47	-14	29	0.44	0.234	5.132	45	323	0.943	large target, good prospect
201	1058.45	1707.29	256058.45	2005707.29	7.35	-27	36	0.5	0.248	6.118	-2	224	0.935	large inverted target
202	1051.64	1699.62	256051.64	2005699.62	7.38	-10	14	0.26	0.154	1.468	39	25	0.865	medium sized, shallow target
203	1033.11	1701.02	256033.11	2005701.02	7.07	-23	27	0.47	0.219	4.225	0	139	0.940	large inverted target
204	1042.26	1717.85	256042.26	2005717.85	6.89	-12	14	0.18	0.127	0.818	1	168	0.777	small inverted target
205	1014.45	1684.94	256014.45	2005684.94	7.37	-9	58	0.84	0.278	8.579	79	86	0.963	large target, good prospect
206	1007.27	1721.38	256007.27	2005721.38	6.93	-52	39	0.32	0.242	5.676	1	253	0.585	looks like 2 targets
207	1048.38	1739.63	256048.38	2005739.63	7.35	-17	34	0.59	0.208	3.605	8	142	0.915	medium sized target, mildly inverted
208	1074.08	1754.30	256074.08	2005754.30	7.45	-11	115	0.69	0.345	16.426	56	230	0.933	very large target, good prospect
209	1103.69	1746.07	256103.69	2005746.08	7.30	-86	38	1.17	0.326	13.803	-7	26	0.874	very large target, significantly inverted
210	1176.43	1743.63	256176.43	2005743.64	7.94	-20	21	0.8	0.243	5.755	16	350	0.870	large target
211	1156.72	1755.93	256156.72	2005755.93	7.42	-79	110	0.43	0.391	23.994	-4	103	0.733	very large shallow target
212	1139.37	1759.91	256139.37	2005759.91	7.51	-41	59	3.6	0.582	79.000	22	352	0.765	too large for single UXO, funny depth, poor fit
213	1206.49	1741.09	256206.49	2005741.09	8.05	-40	37	0.7	0.285	9.216	-4	74	0.863	large target, mildly inverted
214	1207.92	1746.94	256207.92	2005746.94	8.24	-122	65	0.42	0.408	27.230	-18	267	0.878	very large target, very inverted
215	1237.77	1751.26	256237.77	2005751.26	8.59	-22	23	0.32	0.228	4.755	19	18	0.917	shallow target, excellent prospect
216	1273.55	1735.67	256273.55	2005735.67	8.62	-68	69	0.63	0.362	19.044	18	349	0.974	very large target, excellent prospect
217	1345.18	1751.21	256345.18	2005751.21	9.41	-1264	334	2.6	1.618	1693.763	3	334	0.481	Killian wreck parts

Table Appendix C-2. Continued

Survey Measured Values								Fit Values						
Targ ID	Local X (m)	Local Y (m)	UTM X (m)	UTM Y (m)	Water Depth (m)	Min Signal (nT)	Max Signal (nT)	Burial Depth (m)	Size (m)	Moment (amp m^2)	Incl. (deg)	Azi. (deg)	Fit Qual.	Analyst Comments
226	1518.18	1736.89	256518.18	2005736.89	9.01	-95	56	0.07	0.292	9.982	-9	78	0.828	large inverted target on surface
227	1504.57	1740.45	256504.57	2005740.45	9.27	-70	70	-0.06	0.366	19.620	-11	59	0.901	very large target, on surface
228	1502.13	1745.49	256502.12	2005745.49	9.20	-156	82	0.47	0.410	27.598	-2	44	0.933	Huge very inverted shallow target
229	1536.84	1731.51	256536.84	2005731.51	8.81	-54	92	0.06	0.316	12.636	7	219	0.947	very large target on surface, excellent prospect
230	1535.29	1753.16	256535.29	2005753.16	8.47	-19	34	-0.04	0.186	2.559	4	104	0.924	large target on surface
231	1494.39	1770.29	256494.39	2005770.29	8.88	-71	152	1.67	0.499	49.621	27	218	0.667	Detrend shows two overlapping targets
232	1499.93	1792.39	256499.92	2005792.39	8.54	-26	130	0.92	0.357	18.148	63	232	0.841	Very large target, good prospect
233	1479.06	1761.25	256479.06	2005761.25	8.30	-11	73	3.35	0.358	18.426	63	295	0.677	large target, poor fit and depth because of
234	1481.97	1787.48	256481.97	2005787.48	8.44	-22	68	0.44	0.259	6.947	8	165	0.815	large shallow target
235	1463.79	1778.67	256463.79	2005778.67	8.98	-35	67	0.12	0.293	10.018	1	163	0.934	large inverted target on the surface
236	1440.47	1780.57	256440.47	2005780.57	8.53	-93	41	0.73	0.363	19.135	-10	347	0.949	very large target, large remnant component
237	1455.77	1792.19	256455.77	2005792.19	8.86	-53	68	0.26	0.307	11.564	18	21	0.667	large shallow target, 2nd target 2 m SE
238	1456.89	1788.08	256456.89	2005788.08	8.94	-35	98	-0.1	0.293	10.107	12	224	0.931	large surface target, 2n target 2m NW
239	1424.58	1760.94	256424.58	2005760.94	8.56	-34	36	0.87	0.301	10.885	-13	181	0.949	large target, large remnant component
240	1430.47	1754.49	256430.47	2005754.49	8.88	-53	20	2.39	0.336	15.139	-31	43	0.604	target is all remnant
241	1435.35	1801.93	256435.35	2005801.93	8.63	-21	30	0.49	0.214	3.905	7	353	0.616	medium sized target
242	1430.89	1798.81	256430.89	2005798.81	8.79	-14	41	0.18	0.193	2.855	88	61	0.684	medium sized shallow target
243	1398.75	1768.53	256398.75	2005768.53	8.50	-40	59	0.01	0.282	9.003	-16	168	0.802	Killian clutter on surface
244	1398.22	1774.41	256398.22	2005774.41	8.48	-106	83	0	0.340	15.655	-16	98	0.648	Killian clutter on surface
245	1358.01	1759.93	256358.01	2005759.93	7.89	-1108	2507	1.99	2.745	8272.443	69	312	0.675	major chunk of the Killian
246	1362.46	1772.66	256362.46	2005772.66	8.61	-296	2191	-1.1	2.169	4082.816	17	107	0.875	major chunk of the Killian
247	1344.95	1759.65	256344.95	2005759.65	9.33	-1264	531	2.16	1.735	2090.636	-12	211	0.700	major chunk of the Killian
248	1328.93	1774.00	256328.93	2005774.00	8.25	-50	61	-0.16	0.284	9.136	1	253	0.913	likely is Killian clutter
249	1329.20	1794.36	256329.20	2005794.36	8.39	-10	48	0.86	0.272	8.039	79	59	0.959	Large Target, good prospect
250	1299.27	1781.06	256299.26	2005781.06	8.16	-157	91	0.37	0.411	27.826	-1	317	0.961	very large and inverted shallow target
251	1286.39	1799.09	256286.39	2005799.09	7.98	-13	23	0.62	0.214	3.939	30	22	0.898	large target, good prospect
252	1240.11	1768.32	256240.11	2005768.32	8.37	-8	18	0.11	0.164	1.765	21	186	0.805	medium sized target on surface, good prospect
253	1223.40	1769.31	256223.40	2005769.31	8.14	-42	102	0.37	0.335	15.043	8	175	0.951	large shallow inverted target
254	1208.27	1775.93	256208.27	2005775.93	7.99	-23	31	0.47	0.244	5.846	16	343	0.848	large target, good prospect
255	1211.09	1796.30	256211.09	2005796.30	8.00	-82	44	0.9	0.359	18.535	-12	327	0.927	large inverted target
256	1210.84	1790.93	256210.84	2005790.93	8.09	-10	32	0.63	0.224	4.492	62	216	0.880	large target, 2nd target 2 m N
257	1125.69	1778.07	256125.69	2005778.07	7.25	-12	21	0.07	0.194	2.899	-5	116	0.927	medium inverted target on surface, good prospect
258	1100.71	1786.27	256100.71	2005786.27	7.28	-44	74	0.81	0.347	16.677	7	69	0.812	large target, excellent prospect
259	1087.20	1783.09	256087.20	2005783.09	6.98	-8	9	0.19	0.146	1.236	6	58	0.859	small target on surface
260	1072.73	1766.63	256072.73	2005766.63	6.97	-18	32	0.23	0.217	4.081	10	98	0.955	medium sized shallow target, good prospect
261	1075.33	1783.12	256075.33	2005783.12	7.26	-6	16	-0.04	0.183	2.463	20	264	0.898	medium sized target on surface
262	1059.26	1763.40	256059.26	2005763.40	7.14	-28	15	0.05	0.202	3.276	-19	96	0.888	looks like clutter
263	1046.99	1768.97	256046.99	2005768.97	7.08	-23	9	0.32	0.184	2.490	-7	286	0.937	looks like clutter
264	1040.60	1779.47	256040.60	2005779.47	6.97	-13	21	1.44	0.253	6.506	16	288	0.926	large deep target
265	1018.73	1763.81	256018.73	2005763.81	6.92	-41	20	-0.05	0.224	4.472	3	65	0.919	large inverted target on surface, good prospect
266	1025.83	1792.61	256025.83	2005792.61	6.61	-15	16	0.81	0.207	3.524	37	6	0.849	looks like clutter
267	1047.52	1804.12	256047.52	2005804.12	6.69	-142	87	0.55	0.370	20.224	-11	313	0.892	large inverted target, good prospect
268	1102.55	1810.49	256102.55	2005810.49	6.86	-22	13	0.97	0.237	5.331	1	14	0.811	looks like clutter
269	1119.27	1820.64	256119.27	2005820.64	7.18	-6	17	0.53	0.182	2.415	18	178	0.885	looks like clutter
270	1113.33	1838.79	256113.33	2005838.79	6.95	-51	83	0.54	0.291	9.820	31	13	0.949	large shallow target, perfect signature, excellent prospect
271	1229.32	1799.21	256229.32	2005799.21	7.92	-57	85	0.3	0.359	18.513	6	207	0.902	looks like several objects
272	1222.83	1820.13	256222.83	2005820.13	7.99	-36	65	0.22	0.306	11.467	30	356	0.902	large shallow targt
273	1228.43	1822.40	256228.43	2005822.40	7.84	-13	31	-0.14	0.188	2.655	42	360	0.826	large surface target
274	1231.09	1830.06	256231.09	2005830.06	7.63	-46	41	0.23	0.263	7.249	-2	338	0.902	large shallow target, good prospect
275	1292.39	1820.80	256292.39	2005820.80	8.10	-14	15	0.51	0.204	3.384	15	15	0.810	large target, may be clutter
276	1288.02	1835.22	256288.02	2005835.22	7.84	-61	105	0.39	0.338	15.442	2	151	0.978	large inverted shallow target, good prospect
277	1315.66	1808.64	256315.66	2005808.64	8.22	-33	113	0.3	0.332	14.667	17	199	0.943	large inverted target, looks complex
278	1330.91	1827.70	256330.91	2005827.70	8.68	-45	50	0.44	0.347	16.655	14	307	0.961	very large target, good prospect
279	1351.30	1808.49	256351.30	2005808.49	8.40	-11	56	0.24	0.312	12.095	66	182	0.899	large shallow target, partial signature
280	1346.81	1817.17	256346.80	2005817.17	8.33	-92	74	0.21	0.326	13.911	-9	80	0.914	large target partial signature
281	1360.34	1824.24	256360.34	2005824.24	8.21	-52	23	-0.74	0.211	3.735	7	342	0.713	partial signature, note depth
282	1351.89	1842.26	256351.89	2005842.26	8.13	-46	115	-0.6	0.284	9.194	12	184	0.794	large target, partial signature
283	1342.80	1842.92	256342.80	2005842.92	8.12	-39	64	-0.24	0.239	5.427	89	358	0.516	large target, partial signature
284	1400.02	1806.37	256400.02	2005806.37	8.77	-22	61	0	0.281	8.920	33	56	0.630	killian clutter
285	1414.54	1844.44	256414.54	2005844.44	7.63	-77	89	-0.46	0.402	26.076	-29	292	0.839	very large inverted target, above surface, good
286	1448.06	1804.54	256448.06	2005804.54	8.50	-102	79	0.07	0.339	15.605	9	281	0.799	very large target, may be Killian clutter
287	1468.29	1824.97	256468.29	2005824.97	8.14	-38	25	0.12	0.219	4.210	-2	329	0.645	looks like clutter
288	1438.44	1842.94	256438.44	2005842.94	7.43	-64	47	0.69	0.348	16.819	3	304	0.947	very large target, good prospect
289	1447.74	1846.80	256447.74	2005846.80	7.39	-239	117	0.23	0.372	20.564	0	3	0.861	lery large shallow target, good prospect
290	1499.54	1832.90	256499.54	2005832.90	8.02	-168	199	0.74	0.431	31.932	-17	216	0.895	huge inverted target, good prospect
291	1482.74	1840.57	256482.74	2005840.57	7.88	-9	19	0.24	0.121	0.709	17	72	0.728	small shallow target
292	1493.38	1848.39	256493.38	2005848.39	7.89	-13	40	0.65	0.272	8.043	30	205	0.951	large target, good prospect
293	1503.58	1871.20	256503.58	2005871.20	7.40	-11	16	-0.09	0.131	0.903	29	16	0.567	small target on surface
294	1510.64	1902.29	256510.64	2005902.29	6.74	-134	110	0.36	0.404	26.456	12	335	0.849	huge shallow target, excellent prospect
295	1479.07	1879.53	256479.07	2005879.53	7.64	-77	50	1.98	0.304	11.198	-35	89	0.635	large target, poor fit from shallow overlapping

Table Appendix C-2. Continued

Survey Measured Values								Fit Values						
Targ ID	Local X (m)	Local Y (m)	UTM X (m)	UTM Y (m)	Water Depth (m)	Min Signal (nT)	Max Signal (nT)	Burial Depth (m)	Size (m)	Moment (amp m^2)	Incl. (deg)	Azi. (deg)	Fit Qual.	Analyst Comments
304	1364.84	1890.90	256364.84	2005890.90	7.14	-24	811	-1.14	0.100	0.403	79	147	0.077	looks like clutter
305	1311.12	1889.89	256311.12	2005889.89	7.62	-100	198	0.06	0.421	29.890	-3	195	0.875	very large target on surface, excellent prospect
306	1292.07	1905.32	256292.06	2005905.32	7.47	-44	108	0.43	0.373	20.745	8	201	0.931	very large inverted target
307	1292.09	1850.82	256292.08	2005850.82	8.00	-12	23	0.15	0.196	2.990	28	310	0.879	medium sized shallow target
308	1281.51	1886.99	256281.51	2005886.99	7.70	-12	12	-0.26	0.138	1.040	-11	200	0.879	small inverted target on surface
309	1263.08	1858.54	256263.08	2005858.54	7.77	-57	42	0.6	0.274	8.207	7	354	0.793	large target
310	1260.47	1867.94	256260.47	2005867.94	7.83	-28	121	3.23	0.627	98.774	84	221	0.942	massive target, too big and too deep to be single
311	1249.23	1868.85	256249.23	2005868.85	7.77	-22	21	0.43	0.240	5.550	8	344	0.785	may be multiple objects
312	1230.21	1853.99	256230.21	2005853.99	7.68	-5	30	0.46	0.201	3.258	84	2	0.854	medium sized target
313	1217.61	1881.82	256217.61	2005881.82	7.70	-61	73	0.53	0.358	18.332	21	317	0.719	very large target, excellent prospect
314	1203.22	1864.16	256203.22	2005864.16	7.39	-110	105	0.06	0.296	10.358	2	279	0.722	very large shallow target, good prospect
315	1177.92	1892.95	256177.92	2005892.95	7.17	-96	94	0.26	0.336	15.205	15	347	0.982	very large shallow target, excellent prospect
316	1160.27	1853.07	256160.27	2005853.07	7.30	-4	15	0.67	0.132	0.917	85	90	0.630	small targt
317	1121.10	1849.90	256121.10	2005849.90	7.19	-15	93	0.81	0.341	15.841	85	64	0.970	very large target, good prospect
318	1065.40	1855.48	256065.40	2005855.48	6.91	-58	125	0.45	0.368	19.877	27	279	0.960	very large shallow target, excellent prospect
319	1045.01	1884.95	256045.01	2005884.95	6.53	-58	43	0.76	0.358	18.337	2	33	0.973	very large target, good prospect
320	1035.86	1884.50	256035.86	2005884.50	6.39	-7	15	2.87	0.365	19.486	31	69	0.880	looks like geology
321	1028.60	1891.17	256028.60	2005891.17	6.12	-101	71	0.48	0.367	19.721	9	60	0.914	very large target, good prospect
322	1157.83	1932.65	256157.83	2005932.65	7.07	-11	34	1.77	0.303	11.082	28	227	0.900	looks like geology
323	1184.62	1921.52	256184.61	2005921.52	6.90	-18	15	0.04	0.159	1.604	-5	129	0.864	looks like clutter
324	1221.73	1900.78	256221.73	2005900.78	7.43	-77	38	-0.1	0.259	6.963	-6	29	0.863	large inverted target on surface
325	1240.50	1914.07	256240.50	2005914.07	7.32	-15	26	2.22	0.359	18.454	38	340	0.948	very large target, partial signature
326	1231.19	1922.92	256231.19	2005922.92	7.03	-54	90	0.14	0.296	10.325	22	289	0.906	large shallow target, excellent prospect
327	1222.22	1937.85	256222.22	2005937.85	7.29	-127	81	-0.07	0.356	18.069	-10	56	0.951	very large target on surface, excellent prospect
328	1399.74	1913.02	256399.74	2005913.02	7.54	-82	48	0.16	0.295	10.312	15	341	0.892	very large target on surface
329	1488.37	1935.64	256488.37	2005935.64	6.76	-24	18	0.93	0.253	6.468	-27	184	0.853	looks like clutter
330	1502.25	1919.31	256502.25	2005919.31	6.68	-5	17	6.81	0.483	45.074	23	176	0.796	looks like geology
331	1391.43	1957.75	256391.43	2005957.75	7.39	-66	44	0.65	0.331	14.566	5	6	0.939	large inverted target, good prospect
332	1410.83	1979.09	256410.83	2005979.09	6.95	-47	103	0.47	0.376	21.326	42	3	0.937	very large shallow target, excellent prospect
333	1288.11	1961.01	256288.11	2005961.01	7.45	-40	29	0.18	0.292	9.914	4	45	0.955	large target on surface, excellent prospect
334	1258.51	1971.38	256258.51	2005971.38	6.87	-23	27	-0.17	0.200	3.219	-1	246	0.888	medium sized target on surface
335	1261.85	1984.06	256261.85	2005984.06	6.85	-46	63	0.14	0.284	9.208	19	68	0.759	large target on surface, good prospect
336	1256.27	1986.85	256256.27	2005986.85	6.85	-38	58	0.21	0.292	9.927	16	56	0.968	large shallow target, good prospect
337	1224.55	1971.32	256224.55	2005971.32	7.21	-20	26	0.33	0.214	3.946	35	340	0.718	looks like clutter
338	1210.64	1975.50	256210.64	2005975.50	7.00	-70	57	2.6	0.516	54.855	31	38	0.788	massive target, unrealiztic depth, geology?
339	1225.20	1997.99	256225.20	2005997.99	6.60	-104	72	0.73	0.454	37.345	-3	54	0.975	massive target, inverted, must look
340	1212.64	2001.99	256212.64	2006001.99	6.51	-99	79	0.36	0.384	22.684	-10	78	0.787	very large inverted shallow target
341	1212.60	2004.79	256212.60	2006004.79	6.49	-19	47	0.85	0.209	3.636	39	148	0.772	large target
342	1110.86	1963.00	256110.86	2005963.00	6.57	-45	69	0.53	0.313	12.244	6	259	0.945	very large inverted target, good prospect
343	1099.28	2013.25	256099.28	2006013.25	6.34	-13	34	1.2	0.243	5.723	26	59	0.669	large deep target, geology?
344	1073.73	1957.29	256073.73	2005957.29	6.68	-19	19	-0.01	0.219	4.206	3	54	0.897	target on surface, looks like clutter
345	1052.34	1966.08	256052.34	2005966.08	6.24	-25	83	0.96	0.335	15.006	32	65	0.946	very large target, partial signature
346	1005.89	2007.66	256005.89	2006007.66	6.66	-45	65	0.4	0.404	26.297	2	333	0.792	very large shallow target
347	1011.42	2011.91	256011.42	2006011.91	6.46	-211	148	0.26	0.453	37.278	10	332	0.927	huge target on surface, excellent prospect
348	1023.43	2023.53	256023.43	2006023.53	6.37	-207	155	0.39	0.460	39.002	-2	350	0.970	huge shallow target, excellent prospect
349	1143.67	2021.60	256143.67	2006021.60	6.13	-43	25	0.8	0.247	6.003	-4	343	0.860	large target, inverted
350	1251.68	2020.27	256251.68	2006020.27	6.77	-14	33	0.49	0.255	6.655	26	248	0.965	looks like two objects
351	1352.79	2018.17	256352.79	2006018.17	6.71	-31	69	0.21	0.319	12.978	5	155	0.961	large inverted shallow target, good prospect
352	1442.79	2011.81	256442.79	2006011.81	6.53	-56	37	0.59	0.301	10.891	8	241	0.559	large inverted target, looks like many objects
353	1520.80	2034.96	256520.80	2006034.96	5.71	-72	91	0.46	0.341	15.801	6	293	0.563	very large target, poor fit from shallow passes
354	1406.93	2062.81	256406.93	2006062.81	6.11	-42	22	0.57	0.285	9.282	-12	12	0.860	large very inverted target
355	1387.53	2037.09	256387.53	2006037.09	6.28	-45	44	0.62	0.334	14.918	9	50	0.754	very large target, good prospect
356	1348.38	2060.68	256348.38	2006060.68	6.17	-18	44	0.4	0.259	6.944	22	137	0.937	large target, excellent prospect
357	1311.21	2069.16	256311.21	2006069.16	6.41	-22	35	0.03	0.230	4.844	-5	262	0.788	large shallow target
358	1273.25	2060.32	256273.25	2006060.32	6.65	-69	82	0.47	0.383	22.414	-4	209	0.980	very large inverted target, excellent prospect
359	1206.19	2052.28	256206.19	2006052.28	6.05	-8	40	3.54	0.449	36.105	84	188	0.963	looks like a deep hot rock
360	1171.53	2030.01	256171.53	2006030.01	6.40	-11	93	0.98	0.323	13.462	86	156	0.970	very large deep target
361	1156.78	2053.63	256156.78	2006053.63	5.95	-75	109	0.44	0.363	19.065	5	257	0.951	very large inverted target, good prospect
362	1149.66	2071.77	256149.66	2006071.77	6.10	-49	18	1.04	0.301	10.908	-46	255	0.937	not UXO
363	1147.25	2042.21	256147.25	2006042.21	6.08	-17	15	1.4	0.204	3.397	-1	31	0.734	looks like geology
364	1144.46	2055.36	256144.46	2006055.36	5.94	-21	16	1.77	0.203	3.348	1	28	0.775	looks like geology
365	1122.21	2068.87	256122.21	2006068.87	6.07	-62	14	0.58	0.283	9.036	-52	117	0.964	signal is all negative, not UXO
366	1016.09	2088.74	256016.09	2006088.74	6.00	-18	19	0.45	0.216	4.013	-2	115	0.887	looks like multiple objects
367	1109.12	2079.20	256109.12	2006079.20	5.75	-29	22	0.42	0.238	5.367	-4	49	0.971	partial signature
368	1111.04	2118.71	256111.04	2006118.71	5.63	-20	12	0.65	0.229	4.808	10	356	0.935	looks like multiple objects
369	1122.42	2117.21	256122.42	2006117.21	5.68	-17	38	0.44	0.250	6.286	32	290	0.925	large target, OK prospect
370	1188.79	2081.14	256188.79	2006081.14	6.01	-20	17	0.08	0.175	2.132	12	319	0.865	medium sized target on surface
371	1227.90	2108.84	256227.90	2006108.84	6.02	-37	30	-0.02	0.236	5.234	2	281	0.933	large target on surface, good prospect
372	1190.53	2105.89	256190.52	2006105.89	6.01	-43	82	1.07	0.409	27.282	8	157	0.829	huge target, deep good prospect
373	1217.18	2073.97	256217.18	2006073.97	6.27	-17	53	-0.04	0.301	10.937	0	66	0.947	very large target on surface, partial signature
374	1221.21	2091.81	256221.21	2006091.81	6.06	-172	121	0.45	0.416	28.839	1	4	0.960	huge very inverted shallow target, good prospect

Table Appendix C-2. Continued

Survey Measured Values								Fit Values						
Targ ID	Local X (m)	Local Y (m)	UTM X (m)	UTM Y (m)	Water Depth (m)	Min Signal (nT)	Max Signal (nT)	Burial Depth (m)	Size (m)	Moment (amp m^2)	Incl. (deg)	Azi. (deg)	Fit Qual.	Analyst Comments
382	1283.53	2100.84	256283.53	2006100.84	6.30	-22	90	-0.12	0.275	8.285	22	78	0.802	large target, partial signature, on surface
383	1394.05	2104.07	256394.05	2006104.07	5.52	-28	23	0.56	0.218	4.141	-3	217	0.636	looks like several objects
384	1399.64	2077.70	256399.64	2006077.70	5.85	-46	67	-0.41	0.330	14.325	15	26	0.795	very large target, partial signature
385	1402.99	2098.32	256402.99	2006098.32	5.51	-24	12	1.22	0.245	5.907	-4	341	0.911	mostly remnant, looks like several objects
386	1411.63	2085.37	256411.63	2006085.37	5.67	-24	20	1.04	0.283	9.034	21	2	0.852	large target in clutter, may be geology
387	1470.43	2090.97	256470.43	2006090.97	5.93	-32	49	0.97	0.299	10.734	27	335	0.825	large deep target
388	1514.10	2114.59	256514.10	2006114.59	5.39	-7	17	0.01	0.146	1.253	79	91	0.933	small target on surface, good prospect
389	1524.32	2142.51	256524.32	2006142.51	5.15	-18	24	0.25	0.202	3.292	5	109	0.764	medium sized shallow target
390	1509.28	2121.17	256509.28	2006121.17	5.32	-10	23	0.4	0.209	3.651	-1	139	0.864	numerous clutter objects
391	1413.42	2142.11	256413.42	2006142.11	5.56	-17	40	1.14	0.289	9.706	56	59	0.893	large deep target
392	1388.32	2130.12	256388.32	2006130.12	5.87	-47	59	0.64	0.354	17.794	22	355	0.810	very large target, partial signature
393	1367.18	2122.74	256367.17	2006122.74	5.85	-10	16	0.56	0.176	2.185	-3	191	0.720	small target, inverted
394	1361.75	2137.61	256361.75	2006137.61	5.86	-51	72	0.28	0.334	14.922	4	113	0.715	very large target, on surface, good prospect
395	1358.81	2110.09	256358.81	2006110.09	5.70	-10	14	0.71	0.175	2.143	-12	210	0.826	small target
396	1345.34	2125.04	256345.34	2006125.04	5.71	-7	17	0.25	0.136	1.010	28	106	0.820	small shallow target
397	1354.39	2153.91	256354.39	2006153.91	5.70	-89	69	0.12	0.361	18.826	11	15	0.900	very large target, partial signature
398	1343.05	2154.08	256343.05	2006154.08	5.87	-128	79	0.22	0.352	17.413	-8	64	0.944	very large target, on surface, good prospect
399	1334.63	2159.63	256334.63	2006159.63	5.72	-43	36	-0.01	0.302	10.997	13	350	0.875	large target, partial signature
400	1328.86	2151.21	256328.86	2006151.21	5.81	-27	64	0.07	0.249	6.212	43	22	0.909	large target on surface, excellent prospect
401	1328.67	2143.80	256328.67	2006143.80	5.90	-26	72	0.57	0.260	7.023	58	21	0.908	large shallow target, excellent prospect
402	1311.15	2146.91	256311.15	2006146.91	5.86	-19	95	0.76	0.367	19.728	50	77	0.938	very large target, excellent prospect
403	1299.56	2167.26	256299.56	2006167.26	5.72	-14	24	-0.28	0.169	1.947	-9	179	0.895	medium sized target on surface, good prospect
404	1285.04	2163.14	256285.04	2006163.14	5.76	-49	79	1.67	0.476	43.227	22	22	0.855	huge deep target, looks like metal
405	1269.61	2122.27	256269.61	2006122.27	5.96	-25	42	0.31	0.248	6.074	13	230	0.866	large shallow target
406	1147.33	2133.99	256147.33	2006133.99	5.67	-16	14	1.5	0.204	3.386	-17	48	0.729	looks like geology
407	1134.21	2162.88	256134.21	2006162.88	5.52	-33	31	0.54	0.247	6.001	9	238	0.924	large target, inverted signature, good prospect
408	1002.60	2167.48	256002.60	2006167.48	5.51	-10	17	0.41	0.184	2.492	9	189	0.894	medium sized target
409	1077.56	2164.92	256077.56	2006164.92	5.27	-6	9	0.09	0.117	0.638	39	62	0.815	small target on surface
410	1130.35	2180.61	256130.35	2006180.61	5.42	-19	23	0.73	0.237	5.302	19	335	0.970	large target, 2 ft deep
411	1144.98	2181.76	256144.98	2006181.76	5.50	-61	40	0.8	0.300	10.798	2	21	0.848	very large target 2 ft deep, good prospect
412	1140.41	2193.89	256140.41	2006193.89	5.46	-27	14	0.47	0.233	5.061	-15	250	0.951	clutter, strongly inverted
413	1162.06	2200.99	256162.06	2006200.99	5.45	-19	49	1.46	0.296	10.366	29	278	0.824	very large target, too deep for UXO
414	1176.50	2206.63	256176.50	2006206.63	5.47	-31	22	1.16	0.295	10.316	18	347	0.900	likely is geology
415	1220.15	2173.60	256220.15	2006173.60	5.61	-34	57	0.62	0.301	10.914	33	325	0.944	very large target, partial signature
416	1234.68	2187.92	256234.68	2006187.92	5.50	-12	26	0.21	0.196	3.006	46	278	0.910	large shallow target
417	1240.26	2217.17	256240.26	2006217.17	5.28	-90	145	0.32	0.397	25.084	16	44	0.962	very large shallow target, excellent prospect
418	1319.98	2215.85	256319.98	2006215.85	5.24	-95	119	0.43	0.388	23.319	-4	129	0.878	partial signature, highly inverted
419	1364.17	2199.23	256364.17	2006199.23	5.48	-18	32	0.24	0.264	7.325	15	239	0.880	multiple objects on the surface
420	1435.05	2218.36	256435.05	2006218.36	5.01	-26	22	0.02	0.226	4.642	-7	261	0.899	large, highly inverted target on surface
421	1460.36	2175.48	256460.36	2006175.48	5.10	-37	27	0.39	0.233	5.038	-23	57	0.773	multiple clutter objects
422	1463.72	2188.34	256463.72	2006188.34	5.07	-22	47	0.28	0.267	7.591	23	283	0.907	very large shallow target, good prospect
423	1480.52	2212.26	256480.52	2006212.26	5.05	-22	27	1.91	0.315	12.460	50	9	0.783	very large, very deep target
424	1483.18	2241.51	256483.18	2006241.51	5.15	-60	86	0.44	0.325	13.786	22	31	0.921	very large shallow target, good prospect
425	1432.20	2258.98	256432.20	2006258.98	4.92	-4	29	2.1	0.295	10.294	31	168	0.801	multiple objects
426	1420.79	2248.50	256420.79	2006248.50	5.00	-42	114	0.6	0.367	19.722	44	25	0.911	very larget target, excellent prospect
427	1380.29	2255.55	256380.29	2006255.55	5.16	-25	33	0.59	0.257	6.802	23	176	0.788	Cal Target #12?
428	1374.13	2264.27	256374.13	2006264.27	5.00	-39	23	1.03	0.346	16.581	7	333	0.791	looks like geology
429	1367.26	2251.32	256367.26	2006251.32	5.19	-33	32	0.12	0.247	6.018	-2	285	0.937	large target on surface, good prospect
430	1361.27	2250.04	256361.27	2006250.04	5.11	-14	24	0.39	0.212	3.818	42	51	0.895	medium sized target
431	1350.76	2237.56	256350.75	2006237.56	5.04	-129	52	0.24	0.352	17.450	-7	355	0.952	very large surface target, excellent prospect
432	1297.41	2230.63	256297.41	2006230.63	5.02	-21	81	0.2	0.256	6.712	48	333	0.927	large shallow target, good prospect
433	1299.29	2238.62	256299.29	2006238.62	4.96	-59	14	0.29	0.235	5.169	-24	355	0.839	looks like clutter
434	1248.25	2253.51	256248.24	2006253.51	4.50	-26	22	0.23	0.204	3.372	7	342	0.868	medium sized shallow target, good prospect
435	1243.29	2259.59	256243.29	2006259.59	4.49	-52	31	0.29	0.269	7.823	-3	348	0.942	large shallow target, good prospect
436	1202.03	2227.13	256202.03	2006227.13	5.42	-39	32	2.61	0.456	37.891	-4	8	0.838	too deep for UXO
437	1184.92	2227.04	256184.92	2006227.04	5.32	-145	111	1.26	0.502	50.653	-6	39	0.804	huge deep target
438	1179.22	2259.57	256179.22	2006259.57	5.32	-12	82	0.56	0.293	10.100	52	101	0.958	very large shallow target, good prospect
439	1144.27	2259.07	256144.27	2006259.07	5.19	-7	13	0.93	0.163	1.718	51	59	0.582	Medium Target, deep
440	1136.49	2258.12	256136.49	2006258.12	5.15	-8	16	0.64	0.185	2.523	39	291	0.791	medium target, not UXO
441	1083.39	2229.55	256083.39	2006229.55	4.95	-9	15	0.69	0.184	2.487	37	13	0.882	medium target
442	1080.37	2222.53	256080.37	2006222.53	4.72	-21	23	0.17	0.186	2.591	10	56	0.875	medium target on surface
443	1105.91	2294.30	256105.91	2006294.30	5.09	-15	24	0.67	0.250	6.269	28	340	0.869	large target
444	1201.17	2301.98	256201.17	2006301.98	5.08	-75	50	0.98	0.335	15.065	1	9	0.916	very large deep target
445	1240.13	2269.76	256240.13	2006269.76	4.54	-35	57	0.48	0.300	10.836	11	80	0.919	very large target, good prospect
446	1268.15	2271.27	256268.15	2006271.27	4.88	-65	35	0.71	0.327	13.942	-4	17	0.960	very large inverted target, good prospect
447	1310.98	2276.17	256310.98	2006276.17	5.34	-33	58	0.73	0.365	19.452	20	70	0.921	very large target, good prospect
448	1311.15	2307.02	256311.15	2006307.02	5.21	-52	15	1.21	0.307	11.630	-24	61	0.909	Not UXO
449	1362.39	2283.45	256362.39	2006283.46	4.85	-38	32	0.66	0.276	8.374	8	34	0.919	large target, good prospect
450	1395.79	2301.77	256395.79	2006301.77	4.82	-12	54	-0.19	0.191	2.800	30	196	0.695	medium target on surface
451	1399.30	2305.87	256399.30	2006305.87	4.79	-16	87	-0.17	0.222	4.354	39	181	0.841	medium target on surface
452	1452.93	2272.53	256452.93	2006272.53	5.24	-11	25	0.22	0.177	2.214	49	17	0.815	medium target on surface

Table Appendix C-2. Continued

Survey Measured Values								Fit Values						
Targ ID	Local X (m)	Local Y (m)	UTM X (m)	UTM Y (m)	Water Depth (m)	Min Signal (nT)	Max Signal (nT)	Burial Depth (m)	Size (m)	Moment (amp m^2)	Incl. (deg)	Azi. (deg)	Fit Qual.	Analyst Comments
460	1480.66	2294.41	256480.66	2006294.41	5.17	-5	15	0.51	0.160	1.647	81	348	0.930	medium sized target
461	1450.77	2321.41	256450.77	2006321.41	5.35	-47	60	1.02	0.329	14.234	22	300	0.847	very large target, fairly deep
462	1430.17	2332.83	256430.17	2006332.83	5.17	-129	61	2.35	0.465	40.231	-12	7	0.824	very large, very deep inverted target, hot rock?
463	1414.42	2328.74	256414.42	2006328.74	5.02	-71	62	1.52	0.387	23.167	18	6	0.850	very large, very deep target, hot rock?
464	1298.71	2324.52	256298.71	2006324.52	4.94	-6	18	0.22	0.157	1.562	35	219	0.694	looks like clutter
465	1058.19	2318.43	256058.19	2006318.43	4.70	-16	22	0.82	0.237	5.312	21	1	0.907	large deep target, looks like geology
466	1079.42	2374.56	256079.42	2006374.56	4.69	-15	33	0.48	0.241	5.623	12	229	0.871	large target
467	1117.14	2341.64	256117.14	2006341.64	5.18	-8	32	2.14	0.355	17.866	65	33	0.915	very large target, partial signature
468	1108.82	2373.56	256108.82	2006373.56	4.77	-8	19	0.44	0.172	2.036	15	117	0.848	medium sized target
469	1160.59	2357.45	256160.59	2006357.45	5.21	-83	145	1.88	0.526	58.328	26	35	0.899	huge target, very deep, perfect dipole
470	1222.88	2376.74	256222.88	2006376.74	4.24	-6	24	0.93	0.209	3.655	49	308	0.931	medium sized target
471	1238.42	2341.96	256238.42	2006341.96	4.91	-18	43	0.84	0.281	8.864	49	334	0.760	this is at least 2 objects
472	1302.93	2349.11	256302.93	2006349.12	4.87	-52	63	0.33	0.256	6.715	-3	181	0.854	large inverted shallow target, good prospect
473	1294.82	2357.88	256294.82	2006357.88	4.83	-69	86	2.16	0.306	11.460	10	271	0.635	large target, very deep
474	1299.12	2360.20	256299.12	2006360.20	4.90	-25	55	0.73	0.288	9.546	38	335	0.876	large target
475	1293.89	2371.35	256293.89	2006371.35	4.85	-102	101	0.44	0.364	19.277	17	320	0.632	large target, 2nd object 2m NE
476	1295.59	2372.75	256295.59	2006372.75	4.85	-55	62	0.44	0.323	13.542	10	297	0.628	large target, 2nd object 2m SW
477	1313.17	2374.80	256313.17	2006374.80	4.99	-91	104	0.65	0.407	26.994	-4	293	0.891	huge target, excellent prospect
478	1360.70	2385.69	256360.70	2006385.69	4.86	-16	109	0.93	0.352	17.426	66	74	0.921	very large target, good prospect
479	1395.32	2378.90	256395.32	2006378.90	5.09	-175	186	-0.39	0.348	16.802	-15	101	0.890	large piece of junk above surface
480	1487.75	2371.05	256487.74	2006371.06	4.74	-65	36	0.56	0.285	9.231	-3	359	0.932	large target, mildly inverted, good prospect
481	1522.14	2392.39	256522.14	2006392.39	4.36	-26	47	0.64	0.242	5.669	79	225	0.866	large target, good prospect
482	1524.86	2407.91	256524.86	2006407.91	3.94	-61	24	0.66	0.294	10.162	-18	340	0.909	large target mostly remnant
483	1523.96	2426.27	256523.96	2006426.27	3.95	-17	17	1.02	0.241	5.569	18	322	0.778	looks like geology
484	1489.71	2401.69	256489.71	2006401.69	4.69	-64	53	0.36	0.302	11.049	7	345	0.947	large target, partial signature, good prospect
485	1468.94	2392.64	256468.94	2006392.64	4.86	-24	35	0.38	0.215	3.988	17	294	0.863	large target, good prospect
486	1466.72	2401.53	256466.72	2006401.53	4.60	-11	21	3.4	0.339	15.535	47	134	0.820	geology
487	1446.10	2404.88	256446.10	2006404.88	4.78	-214	126	1.13	0.476	43.225	-5	340	0.911	huge target, deep, strongly inverted (?)
488	1412.65	2414.77	256412.65	2006414.77	4.92	-11	39	1.76	0.305	11.394	62	67	0.898	very large target, partial signature
489	1418.95	2427.87	256418.94	2006427.87	4.82	-95	68	1.17	0.462	39.558	5	350	0.830	huge deep target, mildly inverted
490	1338.50	2391.30	256338.50	2006391.30	4.89	-167	138	1.07	0.497	48.970	6	339	0.706	huge object, partial signature, poor fit
491	1300.08	2393.30	256300.08	2006393.30	4.78	-32	29	2.68	0.263	7.269	18	326	0.622	likely is geology
492	1302.68	2417.79	256302.68	2006417.79	4.88	-97	69	0.26	0.337	15.356	0	323	0.878	very large shallow inverted target, good prospect
493	1258.65	2396.07	256258.65	2006396.07	4.65	-44	59	0.92	0.313	12.224	26	351	0.779	very large target, too many crossing passes
494	1080.19	2422.33	256080.19	2006422.33	4.13	-103	78	-0.17	0.286	9.331	11	339	0.722	large target on surface, good prospect
495	1064.62	2421.06	256064.62	2006421.06	4.10	-42	54	1.33	0.367	19.830	26	358	0.875	very large deep target
496	1171.50	2476.81	256171.50	2006476.81	4.53	-22	90	4.61	0.755	171.918	32	181	0.872	massive signal, >4m deep, must be geology
497	1237.41	2431.19	256237.41	2006431.19	4.64	-20	52	0.74	0.298	10.569	6	218	0.774	very large target
498	1258.70	2453.88	256258.70	2006453.88	4.69	-13	74	0.93	0.328	14.102	18	117	0.857	very large deep target,
499	1268.65	2432.93	256268.65	2006432.93	4.80	-22	32	0.01	0.243	5.746	7	301	0.869	large target on surface, excellent prospect
500	1298.10	2459.81	256298.10	2006459.81	4.69	-183	189	-0.41	0.231	4.935	55	283	0.177	large target, too many crossing passes
501	1301.99	2470.24	256301.99	2006470.24	4.89	-101	85	-0.01	0.299	10.722	12	35	0.618	large target on surface
502	1394.18	2454.62	256394.18	2006454.62	4.90	-30	72	1.08	0.371	20.373	39	18	0.710	large target, analyzes as deep, maybe not
503	1425.20	2444.36	256425.20	2006444.36	4.80	-51	52	0.5	0.290	9.793	-2	331	0.807	large target, good prospect
504	1470.26	2439.54	256470.26	2006439.54	4.39	-60	77	0.53	0.321	13.246	20	358	0.926	large target, good prospect
505	1466.07	2447.13	256466.07	2006447.13	4.32	-93	57	0.72	0.384	22.695	-2	6	0.919	large inverted target, good prospect
506	1475.32	2452.70	256475.32	2006452.70	4.31	-41	44	0.1	0.338	15.380	-9	313	0.823	very large target on surface, partial signature
507	1485.39	2443.31	256485.39	2006443.31	4.16	-144	150	0.47	0.435	32.952	-1	227	0.909	very large target, partial signature
508	1493.14	2471.86	256493.14	2006471.86	4.30	-12	40	3.32	0.352	17.411	63	141	0.782	geology
509	1500.61	2437.98	256500.61	2006437.98	4.06	-35	25	2.79	0.280	8.819	5	16	0.453	geology
510	1515.19	2459.57	256515.19	2006459.57	4.06	-8	29	2.54	0.197	3.081	88	343	0.565	large target, analyzes as hot rock
511	1518.61	2466.06	256518.61	2006466.06	4.05	-46	49	1.28	0.278	8.606	70	311	0.680	large deep target
512	1529.54	2447.05	256529.54	2006447.05	3.94	-29	50	0.64	0.360	18.681	-15	281	0.661	multiple objects
513	1516.36	2442.08	256516.36	2006442.08	4.05	-11	33	-0.17	0.152	1.396	51	167	0.832	medium sized target on the surface
514	1537.73	2479.26	256537.73	2006479.26	3.76	-25	20	0.99	0.262	7.183	12	337	0.918	large target buried fairly deep
515	1544.33	2488.38	256544.33	2006488.38	3.80	-49	19	0.77	0.278	8.588	-15	44	0.823	large target, partial signature
516	1496.77	2488.11	256496.77	2006488.11	4.20	-12	59	0.99	0.297	10.513	68	85	0.888	large target, fairly deep
517	1474.01	2496.59	256474.01	2006496.59	4.36	-28	72	1.76	0.335	15.031	46	140	0.443	looks like geology
518	1433.99	2509.29	256433.99	2006509.29	4.77	-31	179	0.91	0.427	31.046	85	90	0.683	very large target, too many passes
519	1384.70	2485.96	256384.70	2006485.96	4.99	-192	76	1.33	0.462	39.431	-21	2	0.781	very large deep target, geology?
520	1385.53	2494.73	256385.53	2006494.73	4.89	-51	129	0.08	0.256	6.692	78	334	0.874	large shallow target, partial signature
521	1324.62	2450.97	256324.62	2006450.97	4.94	-5	30	0.35	0.174	2.112	90	232	0.905	medium sized shallow target, good prospect
522	1321.05	2460.98	256321.05	2006460.98	5.02	-19	117	0.12	0.257	6.777	62	195	0.921	large shallow target, good prospect
523	1329.22	2462.49	256329.22	2006462.49	4.90	-22	28	0.36	0.160	1.646	49	240	0.492	poorly defined, too many passes
524	1329.94	2473.29	256329.94	2006473.29	5.05	-31	64	0.82	0.246	5.942	86	91	0.390	too many passes
525	1243.32	2476.47	256243.32	2006476.47	4.53	-14	15	-0.25	0.147	1.267	18	10	0.794	medium sized target on surface
526	1517.38	2523.28	256517.38	2006523.28	4.07	-85	39	0.78	0.368	19.928	-5	315	0.950	strongly inverted, 2 ft deep
527	1506.18	2530.26	256506.18	2006530.26	4.14	-52	84	0.26	0.303	11.097	39	347	0.943	large shallow target, good prospect
528	1502.41	2527.06	256502.41	2006527.06	4.10	-16	20	0.01	0.143	1.177	87	90	0.592	much larget target 2 m NE
529	1483.65	2532.64	256483.65	2006532.64	4.37	-185	116	0.7	0.445	35.295	3	7	0.881	very large target, partial signature
530	1235.18	2523.26	256235.18	2006523.26	4.01	-39	42	0.65	0.275	8.348	35	344	0.846	may be geology